SCREW PROPELLER EFFICIENCY.

By A. G. GREENHILL.

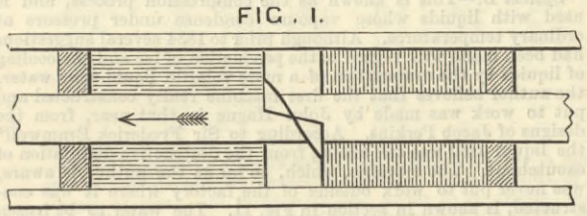
No. I.

NOTWITHSTANDING the valuable writings of Rankine, the Froudes senior and junior, Cotterill, Rigg, Parsons, and others in this country, besides numerous continental authors, on the theory of the screw propeller, it is conceded on many hands that the theory is still in some respects unsatisfactory, and does not give a certain answer to many questions propounded in practice. It is proposed then, in the present papers, to lay before the readers of THE ENGINEER a Theory of the Screw Propeller, and an Investigation of its Efficiency; and in order to make the theory as simple as possible, to begin by neglecting all extraneous disturbing causes—such as fluid friction, &c.—which tend to mask the main causes and effects at work, but afterwards to consider separately the effect of these separate disturbing forces.

I.—ELEMENTARY THEORY OF THE SCREW PROPELLER.

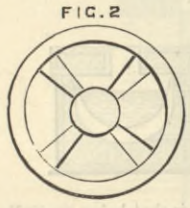
(1) In order to represent the action of a screw propeller in the simplest manner possible, let us begin by the consideration of a screw with smooth, fan-shaped blades, of uniform pitch, revolving with constant angular velocity, and advancing axially with constant linear velocity, the screw being enclosed in a fixed coaxial cylinder which it just fits, the ends of the cylinder being closed, and the cylinder filled with water, as in

FIG. 1.



Figs. 1 and 2. The cylinder may then be considered as a prolongation of the cylindrical casing of the propeller described by the Hon. R. C. Parsons in the "Proceedings" of the Institution of Mechanical Engineers, 1879. We are thus enabled to dispense for the present with the consideration of the discontinuity of pressure at the surface of the propeller stream; also, the ends of the cylinder being closed, there can be no backward momentum imparted to the water. This representation of the action of the propeller differs then from that usually given, where the thrust is supposed due to the backward momentum imparted to the water, in exactly the same manner as the action of the Jonval pressure or reaction turbine differs from that of the Girard impulse turbine, as explained in Professor Unwin's lecture on "Water Motors," delivered at the Institution of Civil Engineers, 5th March, 1885.

FIG. 2



(2) As the screw advances with rotation from one end of the cylinder to the other, the still water in front of the screw is changed into water rotating with constant angular velocity behind the screw, the screw being of uniform pitch, and the blades of sufficient size; and, in fact, the screw acts in exactly the same manner as a revolving drill boring its way into a substance, laminated like sheets of paper, in planes perpendicular to the axis—as explained by Professor J. H. Cotterill in his paper on the "Theory of the Screw Propeller," in the "Annual" of the Royal School of Naval Architecture for 1873.

(3) The couple required to keep the screw rotating will be equal to the angular momentum generated in the water per second, and this will be true whether fluid friction is taken into account or not; while if the screw is smooth, the thrust of the screw multiplied by the pitch will, by the principle of virtual velocities or work, be equal to the turning couple multiplied by 2π.

(4) Taking a foot and second as units of length and time, let

a = diameter of shaft,
d = „ propeller,
p = pitch of „
u = velocity of advance of the propeller through the water,
n = number of revolutions per second;

then np is called the speed of the screw, being the velocity with which it would advance in a solid nut, that is, with no slip; and $np-u$ is called the slip; the ratio $\frac{np-u}{np}$ is called the slip ratio, and is denoted by s, so that

$$\frac{u}{np} = 1-s,$$

and $100\,s$ is the percentage of slip.

(5) Now if the screw advances through the water with no slip, it would not set the water in motion at all, the thickness of the blades being supposed indefinitely small; but if the velocity of advance u is less than the speed of the screw np, the water behind the screw will be left rotating with constant angular velocity in the same direction of rotation of the screw, and making

$$n-\frac{u}{p}$$

revolutions a second, so that the angular velocity of the water behind the screw is

$$2\pi\left(n-\frac{u}{p}\right).$$

(6) If m denotes the density of water in pounds per cubic foot, then for sea-water $m = 64$, about; and the mass of water acted on per second

$$M = \tfrac{1}{4}\pi m (d^2 - a^2) u;$$

and the angular momentum generated per second

$$\begin{aligned} M k^2 w &= \tfrac{1}{32}\pi m (d^4 - a^4)\, 2\pi\left(n-\frac{u}{p}\right) \\ &= \tfrac{1}{16}\pi^2 m (d^4 - a^4)\, u\left(n-\frac{u}{p}\right) \\ &= m (A^2 - B^2)\, u\left(n-\frac{u}{p}\right), \end{aligned}$$

where A denotes the disc area of the propeller, and B the area of the cross section of the shaft or boss of the screw.

Taking the dynamical unit, the poundal, for unit of force, then L, the turning couple of the screw, must be equated to the angular momentum generated per second, so that

$$L = m (A^2 - B^2)\, u\left(n-\frac{u}{p}\right);$$

and if T denotes the thrust of the screw,

$$T\,p = 2\pi L,$$

or

$$T = 2\pi m (A^2 - B^2)\frac{u}{p}\left(n-\frac{u}{p}\right).$$

In Rankine and Froude's papers the statical unit of force of the pound is employed, and the above values of L and T are therefore divided by g or 32; so that $\frac{m}{g}$ can be replaced by the number 2 to agree with their results.

(7) Returning to the actual steamship, then u will represent the velocity of the ship, neglecting the action of the hull in the wake T, the thrust of the screw will be equal to the resistance of the ship, and L will represent the turning moment of the engines, so that the

$$\text{I.H.P.} = \frac{2\pi L n}{550\,g},$$

$$\text{E.H.P.} = \frac{T u}{550\,g},$$

Taking the H.P. as doing 550 foot-pounds or $550\,g$ foot-poundals per second and denoting the efficiency

$$\frac{\text{E.H.P.}}{\text{I.H.P.}} \text{ by } e$$

then

$$e = \frac{T u}{2\pi L n} = \frac{u}{np} = 1 - s,$$

or

$$e + s = 1.$$

(8) The preceding theory as applied to an actual vessel involves the assumption of a screw of uniform pitch, the blades being smooth and thin and of sufficient size to form a complete column of revolution; and in addition the assumption of no backward motion imparted to the water. The previous theories of the action of the propeller all proceed on the assumption that the thrust is due to the backward momentum imparted to the water, but careful observation of the wake of an Atlantic steamer will show that the wake of the screw does not recede from the stern appreciably faster than the wake undisturbed by the screw; otherwise, in addition, a contraction of the screw wake would be observable—a thing it is universally conceded does not take place. Whence, then, it will be asked, does the thrust arise? The answer is, in the increased pressure in the water in rear of the screw; and this increase of pressure will be investigated hereafter. We are justified, then, proceeding from the action of the propeller as represented in Figs. 1 and 2, in comparing the action of the ordinary screw propeller with that of the jonval pressure turbine, in which the passages are always full of water and the pressure of the water is the cause of the action, and which is capable of working when drowned under water, rather than in comparison with the Girard impulse turbine, where the water acts principally without increase of pressure, and the wheel passages are not filled.

(9) Returning again for the present to the elementary theory of the propeller, as given above, we have to seek for the most favourable relations between the different variables represented by a, d, A, B, n, p and u. The problem, as usually presented to the marine engineer, is to design engines of the greatest efficiency for a vessel of given size to attain a given speed; then u is given, and also T, from considerations of the size and shape of the vessel; and A, B, n, and p have to be chosen, so as to make e the efficiency as great as possible. In the first place is seen the advantage of making A, and therefore d, the diameter of the propeller, as large as possible; and the thrust varying very nearly as A^2 shows in this respect an advantage of the single screw over twin or multiple screws, and also so far as weight of propeller is concerned.

(10) Having settled on the value of d, the next problem is to proportion the pitch p and the revolutions n so as to make the efficiency e as nearly unity as possible. Now A, B, T and u being given, then $\frac{np-u}{p^2}$ is constant, so that if P denotes the pitch when the slip, and therefore efficiency, is 50 per cent.

$$\frac{np-u}{p^2} = \frac{u}{P^2},$$

$$np = u\left(1 + \frac{p^2}{P^2}\right),$$

$$n = u\left(\frac{1}{p} + \frac{p}{P^2}\right)$$

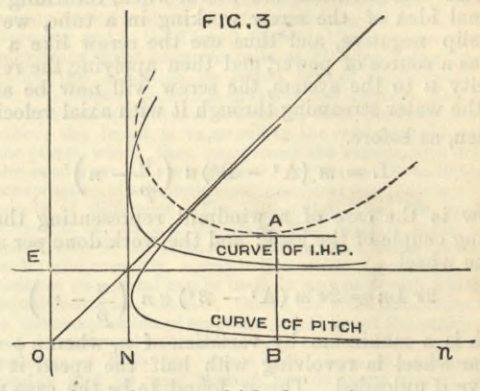
$$= \frac{2u}{P} + u\left(\frac{1}{V\,p} - \frac{V\,p}{P}\right)^2,$$

so that n is a minimum when $p = P$, and then $n = \frac{2u}{P}$.

Taking n, the revolutions, as abscissa, and p, the pitch, as ordinate, the curve connecting them is a hyperbola whose equation is $np = u\left(1 + \frac{p^2}{P^2}\right)$, and taking the speed of screw np, or the I.H.P., as ordinate, the curve connecting them is a hyperbola, Fig. 3, and starting from 50 per cent. slip and efficiency, an increase of pitch will require increased revolutions and increased I.H.P., and is, therefore, very undesirable;* diminishing the pitch, however, and increasing the revolutions, the I.H.P. rapidly diminishes, and at last for very small pitch and very large number of revolutions, so that the slip is indefinitely diminished, we have theoretically the efficiency ultimately unity.

(11) In practice, of course, the effect of fluid friction makes itself felt long before this point of zero pitch is reached, so that in reality the curve of I.H.P. is more like the dotted curve of Fig. 3; and the chief object of our theoretical investigation is to discover the position of the point A on this dotted curve, where the tangent is

FIG. 3



parallel to the axis On, which determines the minimum I.H.P., and, therefore, maximum efficiency. We shall return to this point hereafter.

(12) Expressed in terms of the slip ratio s,

$$np = \frac{u}{1-s},$$

and

$$L = m (A^2 - B^2)\frac{u^2}{p}\frac{s}{1-s},$$

$$T = 2\pi m (A^2 - B^2)\frac{u^2}{p^2}\frac{3}{1-3},$$

Measured in foot-pounds per second, the work done by the engines is $2\pi Ln$, and the work done against the resistance is Tu, and their difference,

$$\begin{aligned} 2\pi Ln - Tu &= 2\pi m (A^2 - B^2)\, u\left(n-\frac{u}{p}\right)^2 \\ &= 2\pi m (A^2 - B^2)\frac{u^3}{p^2}\left(\frac{s}{1-s}\right)^2 \end{aligned}$$

represents the loss of work not utilised in propulsion. Of this loss, one-half appears as the kinetic energy generated per second in the revolving motion of the screw wake, the other half being the loss due to shock of the impulse of the water on the blades. It is impossible entirely to suppress the first loss of energy, called the churning action of the propeller, as it is from this churning action that the thrust of the propeller arises, although by making the pitch very small, and increasing the revolutions, and so diminishing the slip, the churning action may be indefinitely diminished.

(13) But the second loss of energy due to shock of impulse may always be entirely suppressed by making the propeller, like Mr. Bennet Woodcroft's, of increasing pitch, so that the speed of the leading edge of the screw is exactly equal to the speed of the vessel, and increasing the pitch backwards to any desired final pitch p. Then the loss of energy per second—

$$2\pi Ln - Tu = \pi m (A^2 - B^2)\, u\left(n-\frac{u}{p}\right)^2,$$

so that since

$$L = m (A^2 - B^2)\, u\left(n-\frac{u}{p}\right)^2,$$

$$T = \pi m (A^2 - B^2)\left(n^2 - \frac{u^2}{p^2}\right);$$

and therefore—

$$\frac{T}{L} = \pi\left(\frac{n}{u} + \frac{1}{p}\right);$$

hence, if λ denotes the effective pitch of the increasing screw—

$$\frac{1}{\lambda} = \frac{T}{2\pi L} = \frac{1}{2}\left(\frac{n}{u} + \frac{1}{p}\right).$$

so that the effective pitch λ is the harmonic mean between the initial pitch $\frac{u}{n}$ and the final pitch p.

(14) When the velocity u and the thrust T are given, then $n^2 - \frac{u^2}{p^2}$ is constant, and putting it equal to N^2, then

$$\frac{u^2}{p^2} = n^2 - N^2,$$

and the efficiency

$$\begin{aligned} e &= \frac{T u}{2\pi L n} \\ &= \tfrac{1}{2}\left(1 + \frac{u}{np}\right) \\ &= \tfrac{1}{2} + \tfrac{1}{2} v\left(1 - \frac{N^2}{n^2}\right); \end{aligned}$$

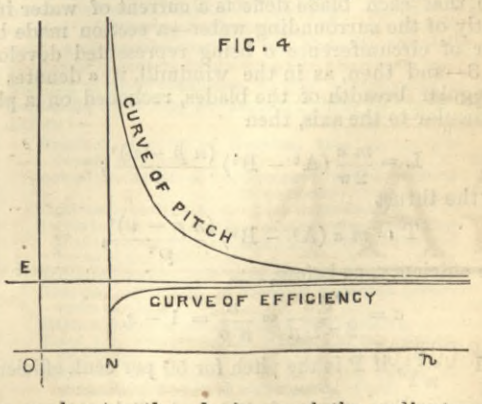
so that N is the minimum value of n, and then the efficiency

$$e = \tfrac{1}{2};\ \text{also } p = \infty.$$

Also the efficiency is increased and tends to the limit unity as n is increased and p correspondingly diminished.

These relations are illustrated graphically in Fig. 4,

FIG. 4



where n denotes the abscissa, and the ordinates of the curves are p and e.

(15) So far we have considered the problem of keeping u and T constant, and varying n and p; but if n and p

* A case of this kind was instanced by Mr. Seaton at the recent meeting of the Institution of Naval Architects.

are kept constant, then, for a screw of uniform pitch, the thrust T is a maximum when $u = \frac{1}{2} n p$, or for a 50 per cent. slip; but the I.H.P. or T u is a maximum when $u = \frac{2}{3} n p$, or for a 33⅓ per cent. slip.

These considerations are useful when, returning to the original idea of the screw working in a tube, we make the slip negative, and thus use the screw like a windmill as a source of power, and then applying the reversed velocity u to the system, the screw will now be at rest, and the water streaming through it with axial velocity u.

Then, as before.

$$L = m\,(A^2 - B^2)\,u\left(\frac{u}{p} - n\right)$$

L now is the case of a windmill representing the controlling couple of the load; and the work done per second by the wheel

$$2\pi\,Ln = 2\pi\,m\,(A^2 - \beta^2)\,u\,n\left(\frac{u}{p} - n\right)$$

which is a maximum by variation of n, when $n\phi = \frac{1}{2} u$, or the wheel is revolving with half the speed it would revolve if unloaded. This is found to be the case practically with those windmills as in Fig. 5, in which there is a

FIG. 5

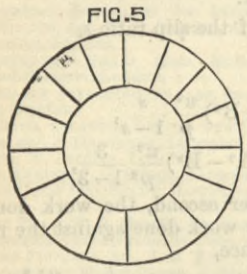
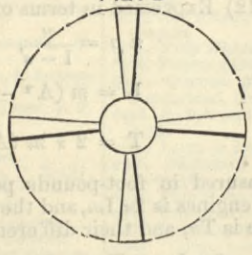


FIG. 6



number of vanes set between two concentric circles, so as to catch all the wind streaming through; in fact, like an ordinary smoke-jack.

(16) The action of a screw propeller must not, therefore, be compared with the action of a screw working in a solid nut, where any slip represents loss of power, but must rather be compared with the action of a windmill or smoke-jack, as was pointed out by Hooke in 1683, and Bramah in 1785, where a certain amount of slip must take place in order to obtain the necessary propulsive power.

(17) In the ordinary windmill—Fig. 6—with four arms, the sails are sufficiently narrow practically to disturb the air without influencing each other, so that we may suppose the air deflected by the sails uninfluenced by the air which would otherwise stream through without meeting the sails. Developing a section of the sails made by a concentric cylinder of circumference c on a plane, as in the theory of the use of the turbine — Unwin, "Water Motors"—Fig. 7. Supposing α the angular breadth of the sails, then $\frac{u - np}{u}\,\alpha$ is the angular breadth of the currents of air which strike the sails, so that the turning angle of the wind—

$$L = \frac{m\,\alpha}{2\pi}(A^2 - B^2)\,u\,\frac{u - np}{u}\left(\frac{u}{p} - n\right)$$

$$= \frac{m\,\alpha}{2\pi}(A^2 - B^2)\,\frac{(u - np)^2}{p}\;;$$

and the work done per second—

$$2\pi\,Ln = m\,\alpha\,(A^2 - B)^2\,(u - np)^2\,\frac{n}{p}\;;$$

which is a maximum by variation n when $np = \frac{1}{3} u$, and then the wheel is revolving with one-third of the speed it would revolve at if unloaded.

FIG. 7.

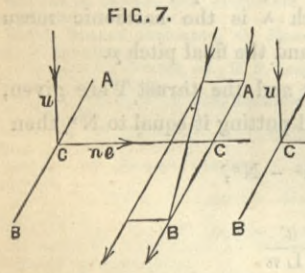
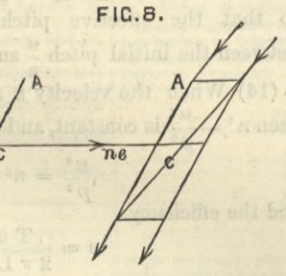


FIG. 8.



This is the question investigated in Smeaton's celebrated "Experimental Inquiry concerning the Natural Power of Water and Wind to turn Mills and other Machines Depending on a Circular Motion," read before the Royal Society, May 3rd and 10th, 1759.

(18) Returning to the analogous question of the screw propeller, it is well known that it is found practically an advantage to reduce the area of the propeller blades so considerably that, instead of a complete column of revolution being formed, as we supposed at first, we may suppose that each blade deflects a current of water independently of the surrounding water—a section made by a cylinder of circumference c being represented developed in Fig. 8—and then, as in the windmill, if α denotes the total angular breadth of the blades, reckoned on a plane perpendicular to the axis, then

$$L = \frac{m\,\alpha}{2\pi}(A^2 - B^2)\,\frac{(np - u)^2}{p}\;;$$

so that the thrust

$$T = m\,\alpha\,(A^2 - B^2)\,\frac{(np - u)^2}{p^2}\;,$$

and the efficiency, as before,

$$e = \frac{T\,u}{2\pi\,L\,n} = \frac{u}{np} = 1 - s,$$

or $e = 1 - \frac{u}{nP}$, if P is the pitch for 50 per cent. efficiency.

The corresponding curves of pitch and efficiency are represented in Fig. 9.

(19) If, however, the pitch of the screw increases from $\frac{u}{n}$ to p, represented developed in Fig. 10, then, using the effective pitch λ given by

$$\frac{1}{\lambda} = \frac{1}{2}\left(\frac{n}{u} + \frac{1}{p}\right),$$

the thrust is given by

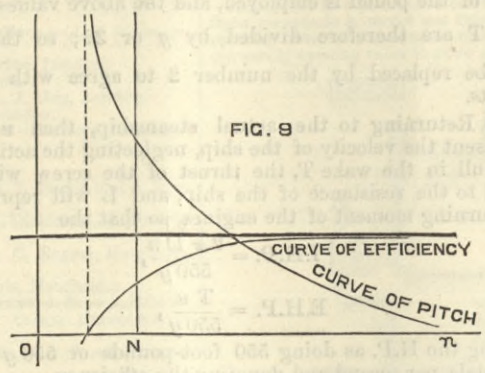
$$T = \frac{1}{2}\,m\,\alpha\,(A^2 - B^2)\,\frac{(np - u)^2\,(np + u)}{p^2\,u}\;;$$

so that the efficiency

$$e = \frac{T\,u}{2\pi\,L\,n} = \frac{1}{2}\left(1 + \frac{u}{np}\right) = 1 - \frac{1}{2}\,s.$$

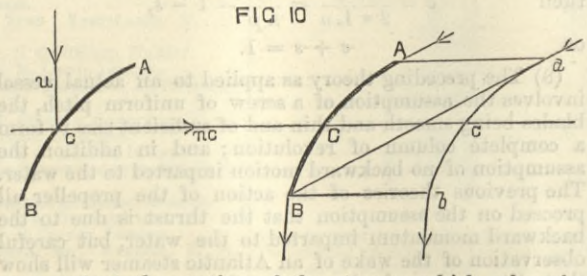
(20) The real state of things will be something intermediate to these two curves of Figs. 8 and 10, and those

FIG. 9



given at first, where a complete column of revolution is supposed to be found, as it is not possible for the streams which are received on the blades not to influence to

FIG 10



some extent the motion of the streams which otherwise would pass through the propeller without deviation, although, from the incompressibility of the water, this amount of deviation will be small.

ON REFRIGERATING AND ICE-MAKING MACHINERY AND APPLIANCES.

By Mr. T. B. LIGHTFOOT.

(*Continued from page* 394.)

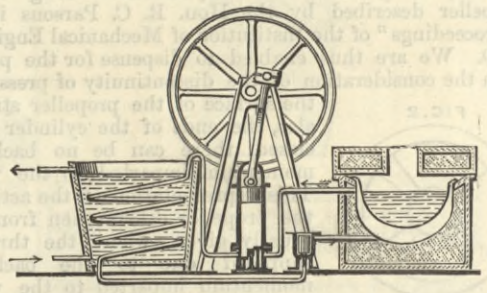
THE advantage gained by the use of a compound pump is due to the action of the intermediate condenser, and to the compression being performed in two stages, by which the losses from the clearance spaces in the large pump are rendered much less than they would be if compression to atmospheric pressure were accomplished in a single operarion. The effect of the pump is said to be such that a vacuum of half a millimetre of mercury, or about 0·0097 lb. per square inch can be continuously maintained; though in actual work about 2½ millimetres, or 0·0484 lb. per square inch, is as low as is necessary. The concentration of the acid is effected in a lead-lined vessel, in which is a coil of lead piping heated by steam, the pressure in the vessel being kept down by means of an ordinary air-pump. No acid pump is needed, as the transfer from one vessel to another is effected by the pressure of the atmosphere. The comparatively cool weak acid on its way to the concentrator is heated in an interchanger by the strong acid returning from the concentrator. Six blocks of ice, each weighing about 560 lb., are formed in about twenty minutes after starting. The charge of acid is said to serve for three makings of ice, after which it becomes too weak and requires to be concentrated. The water being admitted into the ice-forming vessels in fine streams offers a large surface for evaporation, and is almost immediately converted into small globules of ice, which fall to the bottom and become cemented together by the freezing of a certain quantity of water that collects there. This water being in a violent state of ebullition, the ice so formed is not solid, but contains spaces or blow-holes, which, as soon as the block is discharged from the vessel, become filled with air and cause opacity. Several attempts have been made to produce transparent ice by the direct vacuum process, but so far without success. Distilled water or water deprived of air has been tried, and hydraulic pressure has been used for compressing the porous opaque blocks; but neither plan has been found practicable commercially. It would appear indeed that the only way to make clear ice by the vacuum process is by forming it in moulds, subjected externally to the action of brine previously cooled by the evaporation of a portion of its water. The cost in this case would necessarily be greater; but the ice would be solid and transparent, and would consequently have a higher commercial value.

The latent heat of liquefaction of water being 142·6 deg. Fah., the total heat to be abstracted in order to produce 1 ton of ice from 1 ton of water at 60 deg. Fah. is 382,144 Fah.-lb. units. Taking the latent heat of vaporisation of water at 32 deg. Fah. to be 1091·7, it is obvious that 350 lb. must be evaporated to make the ton of ice. But in addition the sensible heat of the evaporated water, which entering at 60 deg. would leave at about 32 deg., would have to be taken off; and this would require the evaporation of about 9¼ lb. more, making a total of about 360 lb., without allowance for loss by heat entering from without, which would be considerable. The total water actually used is given by Mr. Pieper at 12 tons per ton of ice, including the quantity required for cooling purposes. The fuel consumption is stated to be 180 lb. of coal per ton of ice; but the author understands a much larger quantity is actually required. It is consumed in generating steam for driving the vacuum pump and the concentrator air pump, and for evaporating the water absorbed by the acid. According to Dr. Hopkinson, the cost of making 1 ton of opaque ice is 4s.; but the author believes experience has shown that a much higher figure is required to cover the necessary expenses for repairs and maintenance, which in some parts of the apparatus are very heavy. Windhausen's machine has not met with any extended application in this country, owing no doubt to the opaque and porous condition of the ice produced by it, and to the large and cumbrous nature of the plant, which must doubtless require great care and supervision in working.

A vacuum apparatus for refrigerating liquids by their own partial evaporation, and for making ice, was brought out in 1878 by James Harrison. Its chief feature is the revolving cylinder or pump, shown in section in Fig. 3, which affords a simple and efficient means of exhausting large volumes of vapour of low tension, without incurring the loss from friction of ordinary piston-packings, and the trouble of keeping them tight and in good working order, while at the same time the first cost is much reduced. The pump consists of a hollow iron cylinder, revolving on a horizontal axis, and divided into compartments by longitudinal partitions of L section. It is partially filled with a non-evaporable liquid, or one which evaporates only at a temperature considerably in excess of that at which the refrigerating liquid is evaporated, and which is also chemically neutral to the vapour that is brought into contact with it. In practice oil is the liquid used. The refrigerating or ice-making vessels, of any convenient form, are connected by a pipe with one end of a fixed hollow axle on which the cylinder revolves; and inside the cylinder another pipe rises up above the level of the liquid, the longitudinal partitions being stopped short at one end to enable this to be done. The compartments move round mouth downwards, carrying with them the vapour with which they are charged, and compressing it to an extent measured by the distance they dip below the surface of the liquid; until, when the lowest position is approached, the compressed vapour is liberated, and rises into a fixed hood near the centre, in communication with a second hollow axle at the opposite end of the cylinder to that at which the vapour enters. Through this second axle the compressed vapour passes to a surface evaporative condenser, in which it is partly condensed by the combined action of direct cooling and of the partial evaporation of water trickling over the surface; the water of condensation, together with any air, is then compressed to the tension of the atmosphere by a small pump, and discharged. By this process the author is informed it is expected to produce opaque ice on a large scale at a cost of about 1s. per ton. The fuel consumption will certainly be very small, because friction, which is a large item in the Windhausen apparatus, is here to a large extent eliminated. There would also be a saving of all the fuel used in concentrating the acid, and of much of the water required for cooling purposes, besides a reduction in the first cost of the plant and in the expense of maintenance.

System B.—This is known as the compression process, and is used with liquids whose vapours condense under pressure at ordinary temperatures. Although prior to 1834 several suggestions had been made with regard to the production of ice and the cooling of liquids by the evaporation of a more volatile liquid than water, the author believes that the first machine really constructed and put to work was made by John Hague in that year, from the designs of Jacob Perkins. According to Sir Frederick Bramwell* the liquid used was one arising from the destructive distillation of caoutchouc. The machine, which, so far as the author is aware, was never put to work outside of the factory where it was constructed, is shown in section in Fig. 11. The water to be frozen

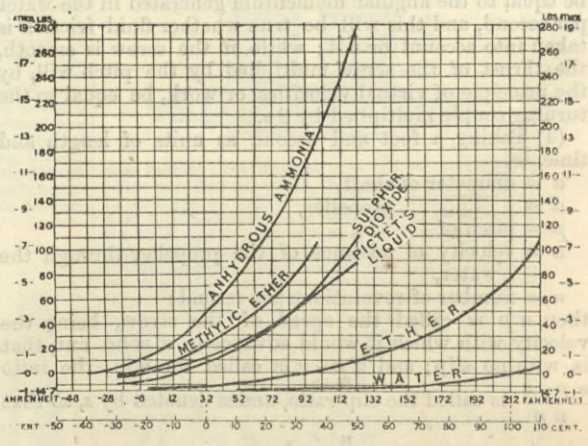
Fig 11



was placed in the jacketted copper pan A, the jacket being partially filled with the volatile liquid, and carefully protected on the outside with a covering of non-conducting material. A pump B drew off the vapour from the jacket, and delivered it compressed into a worm C, around which cooling water was circulated, the pressure being such as to cause liquefaction; the liquid collected at the bottom of the worm, and returned to the jacket through the pipe D, to be again evaporated. This apparatus, though in some respects crude, is yet the parent of all compression machines used at the present time, the only improvements made since the year 1834 having been in matters of constructive detail.

The next advance was made in 1856 and 1857 by James Harrison, who brought out a machine embodying the same principles as that of Perkins, but worked out on a larger and more practical scale. It was taken up by the late Mr. Siebe, and was the first ice-making machine that really came into practical use in this country, and was employed on a commercial scale. An improved apparatus of

Fig 12



this kind, in which ether is used as the refrigerating agent, is still manufactured by Messrs. Siebe, Gorman, and Co. The vapour tensions of ether are shown graphically in Fig. 12,† and are also given in the appended Table 2. It is a not very volatile liquid, of specific gravity 0·720, having a latent heat of vaporisation of 165, and a specific gravity of vapour of 2·24 compared with air. Its boiling point at atmospheric pressure is 96 deg. Fah. Messrs. Siebe, Gorman, and Co.'s machine, applied to the manufacture of clear ice, is shown in plan and elevation in Figs. 1 and 2. It consists of a refrigerator A, a water-jacketted pump B, driven by the surface-condensing steam engine C, an ether condenser D, and ice-making tanks E containing copper moulds, around which brine cooled to a low temperature in the refrigerator is circulated by the pump F. The refrigerator is a cylindrical vessel of sheet copper, containing clusters of horizontal solid-drawn copper tubes, through which the brine successively circulates. The shell is connected with the pump B by a pipe, the liquid ether from the condenser being admitted through a small pipe having a cock G, which is so adjusted as to pass the precise weight of ether that the pump B will draw off. What this weight is depends entirely on the pressure at which evaporation occurs; the greater the density of the vapour, the greater is the weight drawn off at each revolution of the pump. The pressure at which evaporation occurs is defined by the temperature to which it is desired to reduce the brine, the boiling point of the ether being regulated so as to give the required reduction of temperature and no more, otherwise the apparatus would not work up to its full capacity. The condenser consists of a cluster of solid

* "Journal of the Society of Arts," 1882, vol. 31, page 77.

† By an error this diagram was referred to as Fig. 1 in our impression of May 21st.

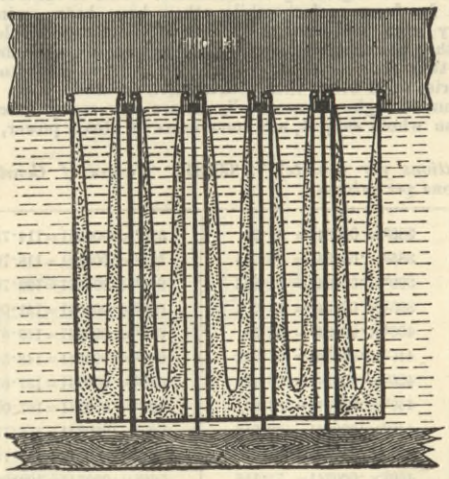
drawn copper tubes placed horizontally in a wood tank, through which cooling water is circulated, the amount of water required in this country being about 150 gallons per hour for every ton of ice made per twenty-four hours. With the temperature of cooling water available in this country, liquefaction generally occurs at a pressure of about 3 lb. per square inch above the atmosphere; but in a warm climate the pressure needed may reach as much as 10 lb. or even 12 lb.

TABLE II.—*Evaporation of Liquids.*

Liquid or gas.		Water.	Anhydrous ammonia.	Sulphuric ether.	Methylic ether.	Sulphur dioxide.	Pictet's liquid.
Specific gravity of vapour, compared with air = 1·000		0·622	0·59	2·24	1·61	2·24	—
		Fah.	Fah.	Fah.	Fah.	Fah.	Fah.
Boiling point at atmo. pressure		212°	−37·3°	96°	−10·5°	14°	−2·2°
Latent heat of vaporisation at atmo. pressure		966	900	165	473	182	—
	Fah.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
	−40°	—	—	—	—	—	—
Absolute vapour tensions in pounds per square inch at different temperatures.	−20°	—	19·4	—	12·0	5·7	11·6
	0°	—	30·0	1·5	18·7	9·8	15·4
	20°	—	47·7	2·6	28·1	16·9	22·0
	32°	0·089	61·5	3·6	36·0	22·7	27·0
	40°	0·122	73·0	4·5	42·5	27·3	31·3
	60°	0·254	108·0	7·2	61·0	41·4	44·0
	80°	0·503	152·4	10·9	86·1	60·2	60·0
	100°	0·942	210·6	16·2	118·0	84·5	79·1
	120°	1·685	283·7	23·5	—	117·5	99·7
	140°	2·879	—	33·5	—	—	—
	160°	4·731	—	45·6	—	—	—
	180°	7·511	—	62·0	—	—	—
	200°	11·526	—	81·8	—	—	—
	212°	14·7	—	96·0	—	—	—

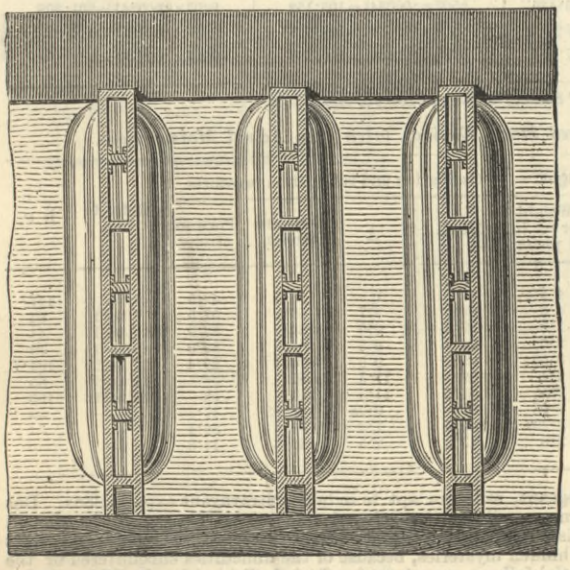
In the apparatus illustrated in Figs. 1 and 2 the ice is made in cans or moulds, as shown in section in Fig 13. The moulds, of sheet copper or steel, are filled with the water to be frozen, and are suspended in a tank, through which is kept up a circulation of cold

Fig 13



brine from the refrigerator. As soon as the ice is formed, the moulds are removed and dipped for a few minutes in warm water to loosen the ice, which is then turned out. The sizes of the moulds vary a good deal, according to the capacity of the machine and the purpose for which the ice is to be used. A common plan is to commence with a thickness of 3in. for a production of 1 ton per twenty-four hours, and to go up to 9in. for 10 tons and upwards. The thickness exercises an important bearing upon the number of moulds to be employed for any given output; for, while a 3in. block can be

Fig. 14



frozen in eight hours, one 9in. thick will take about thirty-six hours. The time, however, varies also according to the temperature at which the brine is worked. For an ether machine, such as that just described, the brine temperature may be taken at from 10 deg. to 15 deg. Fah. Another method is that known as the cell system, which is shown in section in Fig. 14. This consists of series of cellular walls of wrought or cast iron, placed from 12in. to 16in. apart, the space between each pair of walls being filled with the water to be frozen. The cooled brine circulates through the cells, the ice gradually forming outside, and increasing in thickness until the two opposite layers meet and join together. If thinner blocks are required, freezing may be stopped at any time, and the ice removed. In order to detach the ice from the walls, it may either be left for a time after the circulation of the brine has been stopped, or a better and quicker plan is to pass some warmer brine through the cells.

In order to produce transparent ice, it is necessary that the water should be agitated during freezing, so as to allow the escape of the air set free. When moulds are used, this is generally done by means of arms having a vertical or horizontal movement, which are either pushed up by the ice as it forms, leaving the block solid, or work backwards and forwards in the centre of the mould, dividing the block vertically into two equal pieces. With cells, agitation is generally effected from the bottom by means of paddles. The ice which forms first on the sides of the moulds or cells is generally transparent enough even without agitation. The opacity gradually increases towards the centre, where the two layers meet and join together. Agitation is therefore more necessary towards the end of the freezing process than at the beginning. As the quantity of air held in solution by water decreases as its temperature is raised, it is obvious that less agitation will be required in hot than in temperate climates; for this reason in India and elsewhere agitation is frequently dispensed with altogether. Machines using ether as the refrigerating medium are also largely made by Messrs. Siddeley and Co., of Liverpool, and Messrs. West and Co., of Southwark; but they present no special features which are not embodied in the apparatus already described, the points of difference being in details to which it is not necessary to refer.

As already stated, the working pressure in the refrigerator must depend upon the extent of the reduction in temperature desired, bearing in mind that, the higher the pressure, the greater will be the work that can be got out of any given capacity of pump. The liquefying pressure in the condenser depends on the temperature of the cooling water, and on the quantity that is passed through in relation to the quantity of heat carried away; and this pressure determines the mechanieal work to be expended. In any given machine the work may be accounted for as follows:—Friction; heat rejected during compression; heat acquired by the refrigerating agent in passing through the pump; work expended in discharging the compressed vapour from the pump. Against which must be set: Work done by the vapour entering the pump. Assuming that vapour alone enters the pump, the heat rejected in the condenser is: Heat of vaporisation acquired in the refrigerator, with the correction necessary for difference in pressure; heat acquired in the pump, less the amount due to the difference between the temperature at which liquefaction occurs and that at which the vapour entered the pump. Though circumstances vary so much that no absolutely definite statement can be made as to the working of ether machines in general, the following particulars, taken from actual experiment in this country, will serve to show what may be expected under ordinary conditions:—

Production of ice, tons per twenty-four hours	15 tons.
,, ,, pounds per hour	1400 lb.
Heat-units per hour abstracted in ice-making	245,000 units.
Indicated horse-power in steam cylinder, excluding that required for circulating the cooling water, and for working cranes, &c.	83 I.H.P.
Indicated horse-power in ether pump	46½ I.H.P.
Thermal equivalent of work in ether pump, units per hour	119,261 units.
Ratio of work in pump to work in ice-making	1 to 2·05
Temperature of water entering condenser	52 deg. Fah.

Assuming the coal consumption per indicated horse-power to be 2 lb. per hour, and the price of coal 15s. a ton, the total cost of

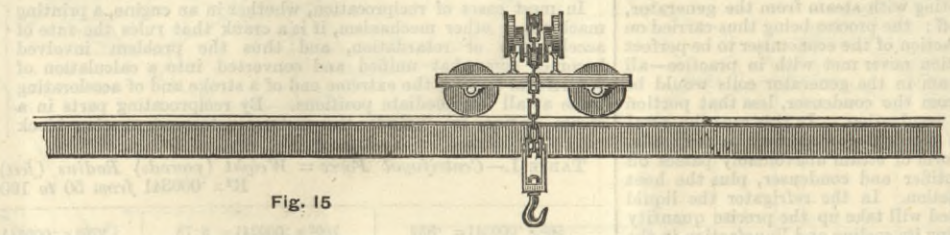


Fig. 15

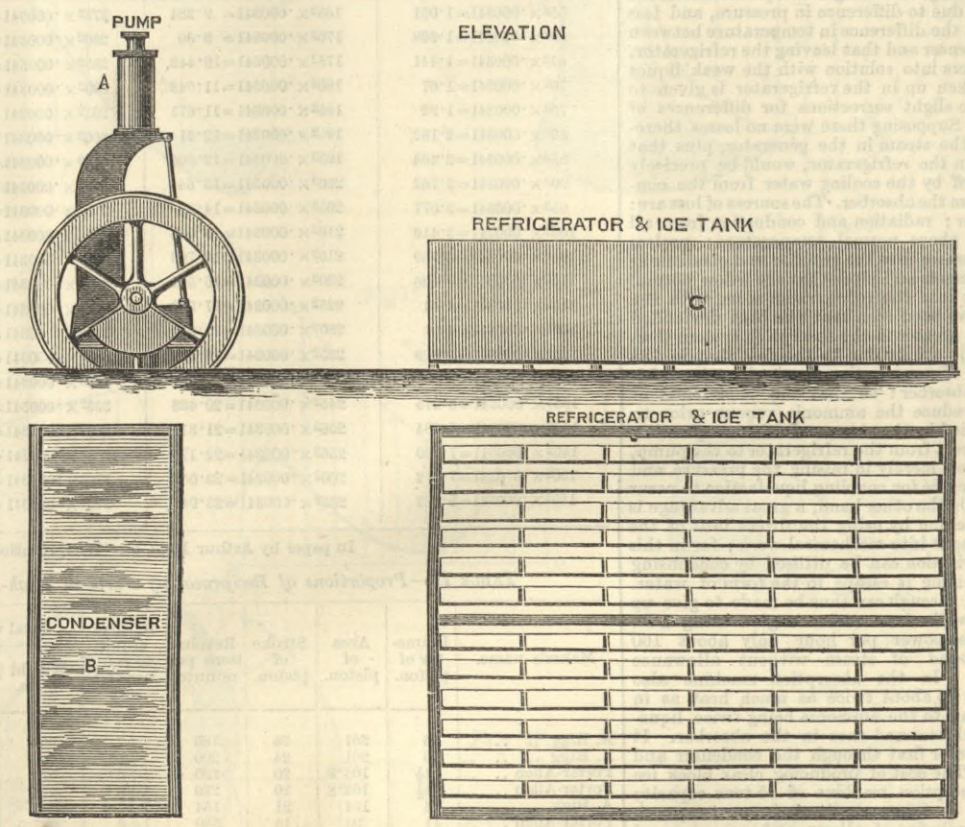
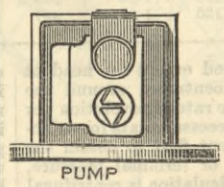


Fig. 16



producing transparent block ice in this country on the ether system, with such a machine as that just referred to, may be taken at about 5s. per ton, excluding allowance for repairs and depreciation. The production of ice would be about 8·3 tons per ton of coal. For cooling water and other liquids, a similar machine is used to that shown in Figs. 1 and 2; but in this case the ice boxes are dispensed with, the liquid being passed direct through the refrigerator without the employment of brine. Methylic ether, a liquid with a latent heat of vaporisation of 473, and which boils under atmospheric pressure at 10·5 deg. below zero Fah., has been employed by Tellier in machinery of practically similar design to that used with ordinary ether. Its curve of vapour tensions is shown in Fig. 12. Tellier's apparatus has never come into use in this country, and need not be further dwelt on; for beyond the difference in size of pump, and the obvious alterations due to the higher working pressures, it presents no features of importance not shown by the machine in Figs. 1 and 2.

Some years ago Raoul Pictet, of Geneva, successfully introduced sulphur dioxide as a refrigerating agent; and in France a large number of his machines have been made and put to work. In this country also they have been used, but to a much smaller extent. The vapour tensions of sulphur dioxide are shown in Fig. 12. It is a liquid with a latent heat of vaporisation of 182, and under atmospheric pressure boils at 14 deg. Fah. This machine is also of similar design to those in which ether is employed; but Pictet combined the refrigerator with the ice-making tanks, the brine being circulated by means of a fan. In this way the space occupied was reduced, and the efficiency somewhat increased. The cost of producing ice by the Tellier and Pictet machines may be taken at practically the same as that by the ether process. Some of the more volatile derivatives of coal tar have been used in compression machines, especially in the United States; but it will be unnecessary to refer to them in detail, as their application has been exceedingly limited. Anhydrous ammonia, which may now be obtained as an article of commerce, has of late years been very largely introduced as a refrigerating agent, more especially in Germany and in the United States. Under atmospheric pressure anhydrous liquid ammonia boils at 37·3 deg. below zero Fah., and under this condition its latent heat of vaporisation is 900. Its curve of vapour tension is shown in the diagram, Fig. 12. So far as the cycle of operation is concerned, it is precisely the same as for ether; the liquid is vaporised in the refrigerator by the action of the pump, which then compresses the vapour, and delivers it into the condenser at such pressure as to cause it to liquefy. In the construction of ammonia machines, however, there are two essential points of difference. For, in the first place, the pressure of the ammonia vapour is much higher than that of ether at the same temperatures, its tension at 60 deg. Fah. being 108 lb. per square inch; and secondly, owing to the action of ammonia on copper, no brass or gun-metal can be used in any part with which the gas or liquid comes into contact. One of the chief difficulties encountered in the compression of ammonia is leakage at the pump gland. The gas is extremely searching, and even at the comparatively low pressure of 30 lb. per square inch above the atmosphere it will readily find its way through an ordinary gland; while at the pressure existing in the condenser, which may be taken at from 150 lb. to 180 lb. per square inch, this tendency is, of course, much aggravated. In order to minimise the leakage and to simplify the construction of the gland, the pumps are frequently made single-acting, as in this way the gland is exposed only to the refrigerator pressure, which is seldom above 30 lb. It is also usual for glycerine, or some lubricant that does not saponify with ammonia, to be injected into the pump, so as to form a liquid seal for the gland, and in some cases for the piston as well; this is the general practice in the United States. In Germany, on the other hand, where the compression machine has been very largely applied, the double-acting pump is more usual. To lessen leakage, Linde provides a chamber in the gland box, into which glycerine or some suitable lubricant is constantly forced at a slightly greater pressure than that prevailing in the condenser, so that the tendency is for the lubricant to leak inwards, instead of ammonia outwards. Any lubricant that does get into the pump passes out with the ammonia, and is separated from it in a suitable vessel. Up to the present time, so few ammonia compression machines have been constructed in England, that as yet no general practice has been established; but on the whole the feeling seems to be in favour of the single-acting pump.

With regard to the other parts of the apparatus, but little need be said. Wrought iron coils or zigzags are used for both the condenser and the refrigerator, their precise form depending on the fancy of the designer. The refrigerator is generally combined with the ice tanks, the cooling pipes being placed either below or at the side of the moulds, sometimes in a separate compartment and sometimes in the same tank. With the cell system an independent refrigerator is used, the cooled brine being circulated by a pump in a similar manner to that described for the ether system. Owing to the low temperature which may be attained by the use of ammonia, care has to be taken in the selection of a brine that will not congeal with the degree of cold to which it will be subjected. A solution of calcium or magnesium chloride in water is generally used. The mechanical work expended in compressing ammonia may be accounted for in a precisely similar manner to that expended in the compression of ether. Notwithstanding that the degree of compression is so much greater with ammonia than with ether, the energy expended in compressing, heating, and delivering the gas is less, owing to the much smaller weight of ammonia required to produce a given refrigerating effect, the weights being in the inverse ratio of the heats of vaporisation, or as 1 to 5·45. For this reason the cost of making ice is much less with ammonia than with ether; one ton of coal being capable of producing as much as 12 tons of ice in well-constructed ammonia apparatus having a capacity of 15 tons per twenty-four hours. With coal at 15s. a ton, the cost of making ice by the ammonia compression system may be taken at about 3s. 9d. per ton for a production of 15 tons per twenty-four hours, exclusive of allowances for repairs and depreciation.

Through the courtesy of the manager of the Linde British Ice Company, the author is enabled to give the following results of a test made by a committee of Bavarian engineers with a machine erected in a brewery in Germany. The test he believes was carried out in an impartial manner; and though it is not put forward by the Linde Company as showing the results attained in the ordinary working of their machines, it will nevertheless be of interest as indicating what may be expected under the most favourable conditions:—

Nominal capacity of machine, tons of ice per twenty-four hours	24 tons.
Actual production of ice, tons per twenty-four hours	39·2 tons.
,, ,, lb per hour	3659 lb.
Heat-units abstracted per hour in ice-making	731,800 units.
Indicated horse-power in steam cylinder, excluding that required for circulating the cooling water and for working cranes, &c.	53 I.H.P.
Indicated horse-power in ammonia pump	38 I.H.P.
Thermal equivalent of work in ammonia pump, units per hour	97,460 units.
Ratio of work in pump to work in ice-making	1 to 7·5.
Total feed-water used in boiler, lbs. per twenty-four hours	26,754 lb.
Ratio of coal consumed to ice made, taking an evaporation of 8 lb. of water per lb. of coal	1 to 26·3.

In this case the pumps were driven by a Sulzer engine, which developed one indicated horse-power with 21·8 lb. of steam per hour, including the amount condensed in steam pipes. Ammonia compression machines are manufactured in this country by Messrs. Siebe, Gorman, and Co., whose apparatus is shown in Figs. 15 and 16;

by the Birmingham Refrigeration Company, and by the Linde British Ice Company.

System C.—This is known as the absorption process, and was first applied by Carré about 1850. The principle employed is chemical or physical rather than mechanical, and depends on the fact that many vapours of low boiling point are readily absorbed by water, but can be separated again by the application of heat to the mixed liquid. A considerable number of machines in which ammonia was used in combination with water as an absorbent were made by Carré in France, but no very high degree of perfection was arrived at, owing to the impossibility of getting an anhydrous product of distillation; the ammonia distilled over contained about 25 per cent. of water, which caused a useless expenditure of heat during evaporation, and rendered the working of the apparatus intermittent. Taking advantage of the fact that two vapours of different boiling points, when mixed, can be separated by means of fractional condensation, Rees Reece brought out in 1867 an absorption machine in which the distillate was very nearly anhydrous. The action of the machine was briefly as follows:—Ordinary liquid ammonia of commerce, of 0·880 specific gravity, was heated, and a mixed vapour of ammonia and water was driven off. By means of vessels termed the analyser and the rectifier, the bulk of the water was condensed at a comparatively high temperature, and run back to the generator; while the ammonia passed into a condenser, and there assumed the liquid form under the pressure produced by the heat, and the cooling action of water circulating outside. The nearly anhydrous liquid was then utilised in a refrigerator in the ordinary way; but instead of the vapour being drawn off by a pump, it was absorbed by cold water or weak liquor in a vessel called an absorber, which was in communication with the refrigerator; and the strong liquor thus formed was pumped back to the generator, and used over again. This apparatus was afterwards improved by Stanley, who introduced steam coils for causing the evaporation in the generator; and then by Pontifex and Wood, who have succeeded in bringing the absorption machine to a considerable state of efficiency. Their apparatus, as applied to the cooling of liquids, is shown in Fig. 4. A is the generator, containing the coils, to which steam is supplied from an ordinary boiler not shown; B, is the analyser; C, the rectifier and condenser; D, the refrigerator or cooler, in which the nearly anhydrous ammonia obtained in the condenser is allowed to evaporate; E, the absorber, through which weak liquor from the generator continually flows and absorbs the anhydrous vapour produced in the refrigerator; F, the economiser or interchanger, by means of which the cold strong liquor from the absorber is heated by the hot weak liquor passing from the generator to the absorber; and G are the pumps for forcing the strong liquor produced in the absorber back into the analyser, where, meeting with steam from the generator, the ammonia is again driven off: the process being thus carried on continuously. Assuming the action of the economiser to be perfect—which of course is a condition never met with in practice—all the heat given out by the steam in the generator coils would be found in the water issuing from the condenser, less that portion directly lost by radiation and conduction. In this case the total heat expended would be that required to vaporise the ammonia, and the water, which in the form of steam unavoidably passes off with the ammonia to the rectifier and condenser, plus the heat lost by radiation and conduction. In the refrigator the liquid ammonia in becoming vaporised will take up the precise quantity of heat that was given off during its cooling and liquefaction in the condenser, less the amount due to difference in pressure, and less also the small amount due to the difference in temperature between the vapour entering the condenser and that leaving the refrigerator. Again, when the vapour enters into solution with the weak liquor in the absorber, the heat taken up in the refrigerator is given to the cooling water, subject to slight corrections for differences of pressure and temperature. Supposing there were no losses therefore, the heat given up by the steam in the generator, plus that taken up by the ammonia in the refrigerator, would be precisely equal to the amount taken off by the cooling water from the condenser, plus that taken off from the absorber. The sources of loss are: Inefficiency of the economiser; radiation and conduction from all vessels and pipes that are above normal temperature; useless evaporation of water which passes into the rectifier and condenser; conduction of heat into all vessels and pipes that are below normal temperature; water passing into the refrigerator along with the liquid ammonia. It will have been seen that the heat demanded from the steam is very much greater in the absorption system than in the compression. This is chiefly due to the fact that in the absorption system the heat of vaporisation acquired in the refrigerator is rejected in the absorber: so that the whole heat of vaporisation required to produce the ammonia vapour prior to condensation has to be supplied by the steam. In the compression system, the vapour passes direct from the refrigerator to the pump, and power has to be expended merely in raising the pressure and temperature to a sufficient degree for enabling liquefaction to occur at ordinary temperatures. On the other hand, a great advantage is gained in the absorption machine by using the direct heat of the steam without first converting it into mechanical work; for in this way its latent heat of vaporisation can be utilised by condensing the steam in the coils and letting it escape in the form of water. Each pound of steam passed through can thus be made to give up some 950 units of heat; while in a steam engine using 2 lb. of coal per indicated horse-power per hour only about 160 units are utilised per pound of steam without allowance for mechanical inefficiency. In the absorption machine also the cooling water has to take up about twice as much heat as in the compression system, owing to the ammonia being twice liquefied, namely, once in the condenser and once in the absorber. It is usual to pass the cooling water first through the condenser and then through the absorber. The cost of producing clear block ice in this country, with an absorption machine of 15 tons capacity per twenty-four hours, may be taken at about 4s. per ton, with good coals at 15s. per ton, exclusive of allowance for repairs and depreciation. About 10 tons of ice can be made per ton of coal consumed, assuming an evaporative duty of 8 lb. of water per lb. of coal.

System D.—In this, which is known as the binary absorption system, liquefaction of the refrigerating agent is brought about partly by mechanical compression and partly by absorption; or else the refrigerating agent itself is a compound of two liquids, one of which liquefies at a comparatively low pressure, and then takes the other into solution by absorption. An apparatus of the first kind was brought out in 1869 in Sydney by Messrs. Mort and Nicolle, who used ammonia, with water as an absorbent. The machine consisted of an evaporator or refrigerater, a pump and an absorber. The evaporator was supplied with strong ammonia liquor, which was vaporised by means of the reduction of pressure induced by the pump, and so abstracted heat from the liquid to be cooled. The weak liquor passing out at the bottom of the evaporator was led by pipes to the pump, where it met with the ammonia vapour, along with which it was forced through cooling vessels under sufficient pressure to cause the solution of the ammonia; and the strong liquor thus formed was again passed into the evaporator. This machine was only used by the inventors in Australia, so far as the author is aware; and he has no particulars as to fuel consumption or cost of working. It was not likely, however, to be a very economical apparatus, because the whole of the water entering the evaporator with the ammonia had to be reduced in temperature, giving up its heat to the ammonia vapour, and to that extent preventing the performance of useful cooling work. But this disadvantage was in some degree compensated for by reducing the temperature of the strong liquor before it entered the evaporator, by means of an interchanger through which the very cold weak liquor passed on its way to the pump. In machines of the second kind, in which both liquids are evaporated at a low temperature, the foregoing objection does not exist; and though this mode of working has not as yet been introduced into this country, it has been successfully employed in the United States for several years by Messrs. De Motay and Rossi. The liquid used is a mixture of ordinary ether and sulphur dioxide, and has been termed ethylo-sulphurous dioxide; its adoption was decided on after a series of experiments with numerous other combinations of ethers and alcohols with acids. In these investigations it was found that liquid ether at ordinary temperatures possessed an absorbing power for sulphur dioxide amounting to some 300 times its own volume; while at 60 deg Fah. the tension of the vapour given off from the binary liquid was below that of the atmosphere. In working, both liquids evaporate in the refrigerator under the influence of the pump; and in the condenser the pressure never exceeds that necessary to liquefy the ether. The compressing pump has less capacity than would be required for ether alone, but more than for pure sulphur dioxide. As to the cost of making ice by this process, the author has no particulars; but he believes it to be somewhat less than with ether. An interesting application of the binary system has lately been made by Raoul Pictet, who found that by combining carbon dioxide and sulphur dioxide he could obtain a liquid whose vapour tensions were not only very much less than those of carbon dioxide, but were actually below those of pure sulphur dioxide at temperatures above 78 deg. Fah. The curve for Pictet's liquid is shown in the diagram, Fig. 12. This is a most remarkable and unlooked-for result, and may open up the way for a much greater economy in ice production than has yet been attained. As to the results that have been obtained with this process, the author has no definite particulars; but he understands it is stated to give a production of 35 tons of ice per ton of coal.

(*To be continued.*)

OBSCURE INFLUENCES OF RECIPROCATION IN HIGH SPEED ENGINES.*

By Mr. Arthur Rigg, M.I.C.E.

Few, if any, modern applications of mathematical research have proved so interesting and instructive to mechanical engineers as those investigations by which Mr. Charles T. Porter first showed how the reciprocation of high-speed pistons might be used to equalise pressures, and conduce to the quiet running of engines driven much faster than the speeds to which all makers of stationary engines had until then been accustomed. His Allen engine, with 12in. cylinder and 24in. stroke, first exhibited in London at the Exhibition of 1862, made 200 revolutions per minute, and attracted much attention at the time; and the principles then enunciated are still carried out by the Southwark Manufacturing Company of Philadelphia, the makers of the engines.

In most cases of reciprocation, whether in an engine, a printing machine, or other mechanism, it is a crank that rules the rate of acceleration or retardation, and thus the problem involved becomes somewhat unified and converted into a calculation of centrifugal force at the extreme end of a stroke and of accelerating force at all intermediate positions. By reciprocating parts in a steam engine, we include the piston, piston-rod, motion block with attachments, and all the connecting-rod except the head at its outer end. Assuming these to be concentrated around the crank pin, then its radius in feet ($= r$) = the rate of revolution per minute ($= R$) and weight ($= W$) furnish all necessary data for calculating accelerating pressures. It is convenient first to obtain the centrifugal force, as that forms the initial or terminal pressure, and the usual formula employed in this calculation is centrifugal force in pounds $= W \times \cdot000341 \times R^2 \times r$. The term $\cdot000341\ R^2$ is a constant, and may be calculated out for given speeds. This has been done in the preparation of Table I., which can be used to facilitate any calculations wherein centrifugal force forms an element. Such elementary subjects are fully treated in elementary textbooks on dynamics; but, in order to secure the use of one system, it will be assumed that all have read the chapters on reciprocating parts in Mr. C. T. Porter's book on the indicator or in the author's "Practical Treatise on the Steam Engine," pages 258 to 283. Therein will be found a complete investigation of the whole subject free from purely mathematical symbols, and easily intelligible to working engineers.

So simple and convincing do these theoretical conclusions appear, that we might fairly anticipate their acceptance and general adoption being followed by great changes in the proportions of ordinary steam engines; because makers and users might naturally be supposed to desire the combined advantages of greater power and diminished cost which accompany the use of higher rates of revolutions. But it cannot be said that such expectations have been realised, although many attempts have been made to carry these theoretical conclusions into practice. But an examination of many so-called "high-speed engines" advertised really possess a speed little, if anything, beyond the corresponding speeds of common types. Their proportions are ill calculated for expansive working, and if their very moderate increase of speed be exceeded, their energies seem devoted to self-destruction. But they seem scientific to ordinary users of steam power, and, being cheap, such engines are quite good enough for such people.

Dynamical relationships in small steam engines produce such insignificant effects in comparison to their proportions, that no difficulties arise except at extremely high speeds; but it is only with engines of large size and power that we are soon brought face to face with heavy dynamical strains, which would seem to be difficult to understand or remove. Yet it is well known that many really powerful engines of this class are running with smoothness, and even with economy; while others are hammering away an uneasy existence with considerable energy. And mere superficial observers accept such evidences as against high speeds, but ignore such evidences in their favour. This, however, is a very shallow sort of conclusion, and every scientific engineer would disdain to submit to the dictation of any such inertia of stupidity. He would prefer to get at any true causes that may influence these irregular results rather than palliate existing evils, much less deny their existence altogether.

It would almost seem as if the usual calculations of the influences of reciprocation in large and powerful engines must continue to pass unnoticed some disturbing influence that really is so important as to render the existing theory an imperfect exponent of things as they really occur, and we now propose to examine a little into the subject, and endeavour to extract some further light as to why one quick-running engine proves a practical failure, while another, made on the same lines of construction, may be thoroughly successful; and we may remember that the successful result of even a single large high-speed engine is ample proof in their favour, and outweighs a thousand failures.

It may be useful first to refer in general outline to the effects produced upon the driving power of an engine by the necessity for acceleration and retardation of its reciprocating parts, and to remind ourselves of those influences which change the distribution of pressure on a piston into something quite different experienced by the crank pin. And those who desire to obtain fuller knowledge of the subject should study it thoroughly; for the present paper does not touch upon many points of value, but it employs the general construction of diagrams given in the author's treatise already referred to, and some of the figures are identical, or nearly so. Since 1872 the writer of this paper has designed and constructed high-speed engines, and has devoted much study to them, and has enjoyed exceptional opportunities for observing their behaviour; this not only in engines—some of considerable power—of his own design, but also in engines by other makers. Some of these engines have been far from perfect, while others have been eminently satisfactory from this particular point of view; and people may argue as they please, that such results condemn high speeds altogether, or that such conclusions prove the general correctness of those theories upon which their construction is based.

Few even of engineers are really aware how many difficulties environ the whole subject, and some users of steam power, more exegeant, still are apt to indulge extravagant expectations. But it may well be remembered that science moves slowly though resistlessly, and it is most unfair to discourage attempts to extract its hidden mysteries, because of the difficulties encountered or the partial failures experienced. Such foolish critics should remember that no invention or improvement ever was perfected at once, nor has anybody ever heard of a second Minerva springing fully equipped from the head of Jupiter.

It may be considered unfortunate for the progress of science that so few engineers publish data of an accurate and complete character, particularly in relation to any attempts to improve the scientific bases of their designs, especially when success is reached only through the channel of some comparative miscalculations, or even failures. And this reluctance is the more regrettable because it frequently happens that a failure lends itself far more readily to the acquiring of a real knowledge of truth than the examination of many a complete success where the stages of progress have been completely lost. We shall avoid this error, and shall give the results of actual experience with high-speed engines that are deserving of the name, taking only two types for illustration, wherein the mass of their reciprocating parts has been avowedly used for equalising the incidence of high pressures and early rates of expansion in one cylinder.

In these two classes full information is at hand, and the author wishes to acknowledge his thankfulness to the Southwark Manufacturing Company of Philadelphia for the valuable information as to the weights of reciprocating parts which they have so liberally afforded and so freely placed at his disposal. The indicator diagrams for these Porter-Allen engines are taken from published sources, and are intended particularly to show the evils arising

* Society of Engineers.

TABLE I.—*Centrifugal Force = Weight (pounds) Radius (feet) × (Revolutions per minute)* $^2 \times \cdot000341$. *Values of Constant* $R^2 \times \cdot000341$ *from 50 to 1000 Revolutions per minute.*

$50^2 \times \cdot000341 = \cdot852$	$160^2 \times \cdot000341 = 8\cdot73$	$270^2 \times \cdot000341 = 24\cdot859$	$380^2 \times \cdot000341 = 49\cdot24$	$580^2 \times \cdot000341 = 114\cdot712$
$55^2 \times \cdot000341 = 1\cdot031$	$165^2 \times \cdot000341 = 9\cdot284$	$275^2 \times \cdot000341 = 25\cdot688$	$385^2 \times \cdot000341 = 50\cdot544$	$590^2 \times \cdot000341 = 118\cdot702$
$60^2 \times \cdot000341 = 1\cdot228$	$170^2 \times \cdot000341 = 9\cdot86$	$280^2 \times \cdot000341 = 26\cdot734$	$390^2 \times \cdot000341 = 51\cdot866$	$600^2 \times \cdot000341 = 122\cdot76$
$65^2 \times \cdot000341 = 1\cdot441$	$175^2 \times \cdot000341 = 10\cdot443$	$285^2 \times \cdot000341 = 27\cdot698$	$395^2 \times \cdot000341 = 53\cdot204$	$620^2 \times \cdot000341 = 131\cdot08$
$70^2 \times \cdot000341 = 1\cdot67$	$180^2 \times \cdot000341 = 11\cdot048$	$290^2 \times \cdot000341 = 28\cdot678$	$400^2 \times \cdot000341 = 54\cdot56$	$640^2 \times \cdot000341 = 139\cdot674$
$75^2 \times \cdot000341 = 1\cdot92$	$185^2 \times \cdot000341 = 11\cdot671$	$295^2 \times \cdot000341 = 29\cdot975$	$410^2 \times \cdot000341 = 57\cdot322$	$660^2 \times \cdot000341 = 148\cdot54$
$80^2 \times \cdot000341 = 2\cdot182$	$190^2 \times \cdot000341 = 12\cdot31$	$300^2 \times \cdot000341 = 30\cdot69$	$420^2 \times \cdot000341 = 60\cdot152$	$680^2 \times \cdot000341 = 157\cdot678$
$85^2 \times \cdot000341 = 2\cdot464$	$195^2 \times \cdot000341 = 12\cdot966$	$305^2 \times \cdot000341 = 31\cdot721$	$430^2 \times \cdot000341 = 63\cdot051$	$700^2 \times \cdot000341 = 167\cdot09$
$90^2 \times \cdot000341 = 2\cdot762$	$200^2 \times \cdot000341 = 13\cdot64$	$310^2 \times \cdot000341 = 32\cdot77$	$440^2 \times \cdot000341 = 66\cdot018$	$720^2 \times \cdot000341 = 176\cdot774$
$95^2 \times \cdot000341 = 3\cdot077$	$205^2 \times \cdot000341 = 14\cdot33$	$315^2 \times \cdot000341 = 33\cdot835$	$450^2 \times \cdot000341 = 69\cdot052$	$740^2 \times \cdot000341 = 186\cdot732$
$100^2 \times \cdot000341 = 3\cdot416$	$210^2 \times \cdot000341 = 15\cdot038$	$320^2 \times \cdot000341 = 34\cdot718$	$460^2 \times \cdot000341 = 72\cdot155$	$760^2 \times \cdot000341 = 196\cdot962$
$105^2 \times \cdot000341 = 3\cdot759$	$215^2 \times \cdot000341 = 15\cdot763$	$325^2 \times \cdot000341 = 36\cdot018$	$470^2 \times \cdot000341 = 75\cdot327$	$780^2 \times \cdot000341 = 207\cdot464$
$110^2 \times \cdot000341 = 4\cdot126$	$220^2 \times \cdot000341 = 16\cdot504$	$330^2 \times \cdot000341 = 37\cdot134$	$480^2 \times \cdot000341 = 78\cdot666$	$800^2 \times \cdot000341 = 218\cdot24$
$115^2 \times \cdot000341 = 4\cdot51$	$225^2 \times \cdot000341 = 17\cdot263$	$335^2 \times \cdot000341 = 38\cdot268$	$490^2 \times \cdot000341 = 81\cdot874$	$820^2 \times \cdot000341 = 229\cdot283$
$120^2 \times \cdot000341 = 4\cdot91$	$230^2 \times \cdot000341 = 18\cdot039$	$340^2 \times \cdot000341 = 39\cdot419$	$500^2 \times \cdot000341 = 85\cdot250$	$840^2 \times \cdot000341 = 240\cdot61$
$125^2 \times \cdot000341 = 5\cdot329$	$235^2 \times \cdot000341 = 18\cdot832$	$345^2 \times \cdot000341 = 40\cdot587$	$510^2 \times \cdot000341 = 88\cdot694$	$860^2 \times \cdot000341 = 252\cdot204$
$130^2 \times \cdot000341 = 5\cdot763$	$240^2 \times \cdot000341 = 19\cdot642$	$350^2 \times \cdot000341 = 41\cdot772$	$520^2 \times \cdot000341 = 92\cdot206$	$880^2 \times \cdot000341 = 264\cdot07$
$135^2 \times \cdot000341 = 6\cdot215$	$245^2 \times \cdot000341 = 20\cdot468$	$355^2 \times \cdot000341 = 42\cdot864$	$530^2 \times \cdot000341 = 95\cdot787$	$900^2 \times \cdot000341 = 276\cdot21$
$140^2 \times \cdot000341 = 6\cdot684$	$250^2 \times \cdot000341 = 21\cdot312$	$360^2 \times \cdot000341 = 44\cdot193$	$540^2 \times \cdot000341 = 99\cdot436$	$920^2 \times \cdot000341 = 288\cdot622$
$145^2 \times \cdot000341 = 7\cdot169$	$255^2 \times \cdot000341 = 22\cdot173$	$365^2 \times \cdot000341 = 45\cdot429$	$550^2 \times \cdot000341 = 103\cdot152$	$940^2 \times \cdot000341 = 301\cdot308$
$150^2 \times \cdot0\ 0341 = 7\cdot672$	$260^2 \times \cdot000341 = 23\cdot052$	$370^2 \times \cdot000341 = 46\cdot682$	$560^2 \times \cdot000341 = 106\cdot938$	$960^2 \times \cdot000341 = 314\cdot27$
$155^2 \times \cdot000341 = 8\cdot192$	$265^2 \times \cdot000341 = 23\cdot947$	$375^2 \times \cdot000341 = 47\cdot593$	$570^2 \times \cdot000341 = 110\cdot798$	$980^2 \times \cdot000341 = 327\cdot496$

In paper by Arthur Rigg, on "Reciprocation," Society of Engineers, 5th April, 1886.

TABLE II.—*Proportions of Reciprocating Parts in High-speed Steam Engines, taken from Actual Measurement.*

Maker's name.	Diameter of piston.	Area of piston.	Stroke of piston.	Revolutions per minute.	Ratio of crank to connecting rod.	Total weight.		Oscillation and retardation pressures.				Refer to Fig.	H.P.
						Weight in lbs.	Weight per sq. in. of piston.	Mean.	±	Outward stroke.	Forward stroke.		
								lbs.					
A. Rigg	16	201	24	180	1÷7	900	4·5	49·5	7	56·5	42·5	3 to 6	147
A. Rigg	16	201	24	200	1÷7	900	4·5	61·2	8·7	69·9	52·5	7 to 10	84
Porter-Allen	11½	103·8	20	230	1÷6	273	2·6	39·4	6·5	45·9	32·9	11 to 14	44
Porter-Allen	11½	103·8	20	230	1÷6	273	2·6	39·4	6·5	45·9	32·9	15 to 16	70
A. Rigg	14	154	21	154	1÷7·4	565	3·66	25·9	3·5	22·4	29·4	17 to 20	104·7
Porter-Allen . ..	11	95	16	350	1÷6	237·5	2·5	69·5	11·5	81	58	21 to 24	85
Porter-Allen	11	95	16	350	1÷6	237·5	2·5	69·5	11·5	81	58	25 to 28	133
Porter-Allen	12	113	24	200	1÷6·16	470	4·15	57	9·25	66·25	47·35	—	—
Porter-Allen	14·5	165	24	200	1÷6	529·5	3·206	43·6	7·2	50·8	36·4	—	—
A. Rigg	12	113	20	130	1÷7	407	3·6	17·3	2·5	19·8	14·8	—	—

MOMENTUM DIAGRAMS OF STEAM ENGINES.

(For description see page 430.

Fig 1

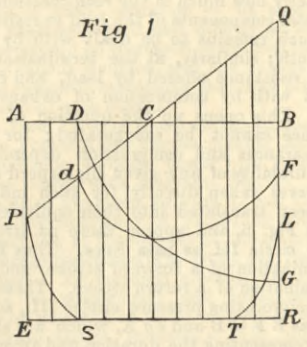


Fig 2.

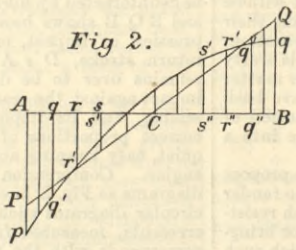


Fig 2'

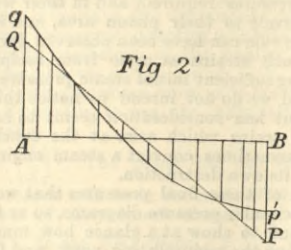


Fig 3.

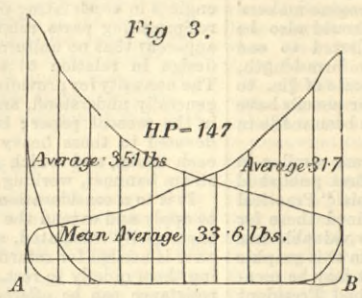


Fig 4.

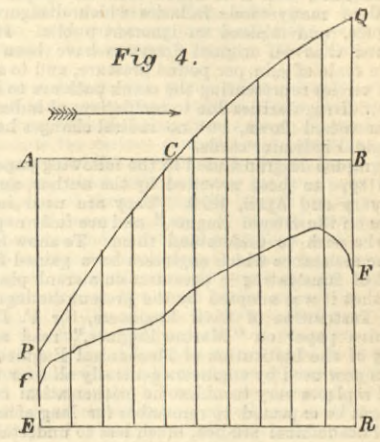


Fig 5.

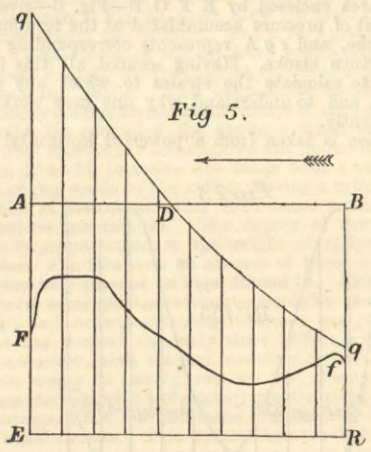


Fig 6.

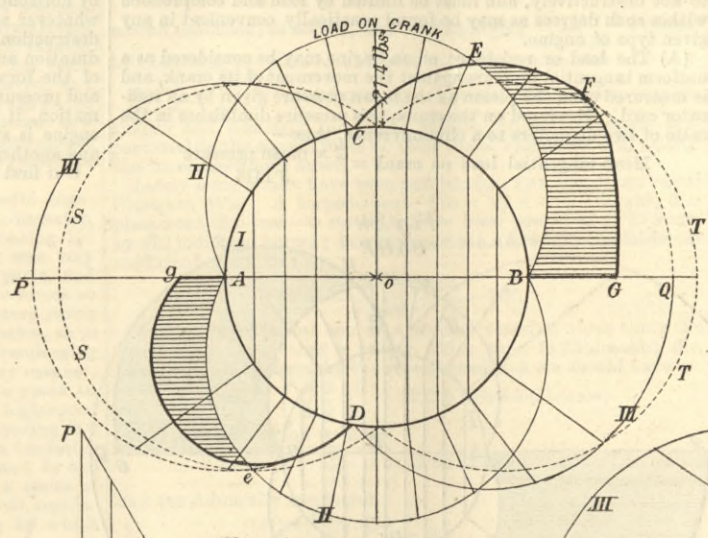


Fig 7.

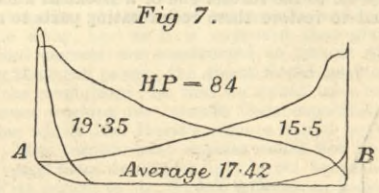


Fig 8.

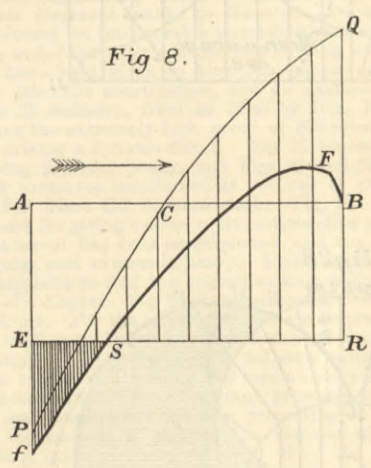


Fig 9.

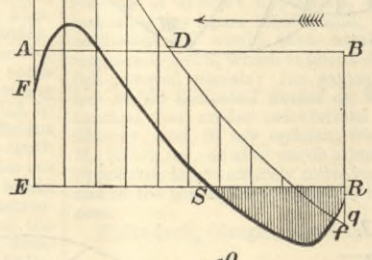


Fig 10.

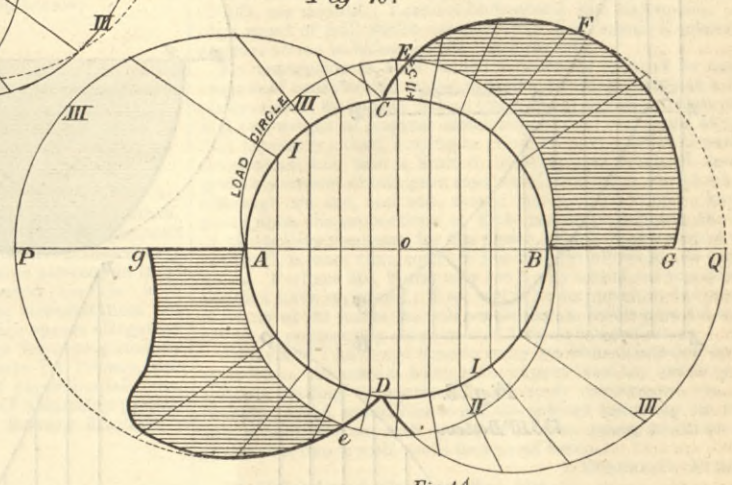


Fig 11.

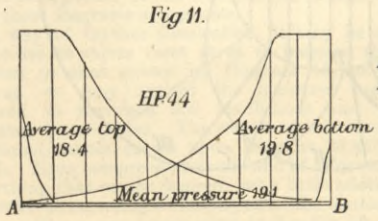


Fig 12.

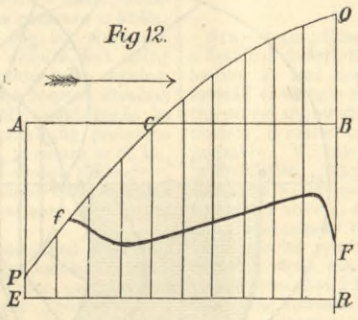


Fig 13.

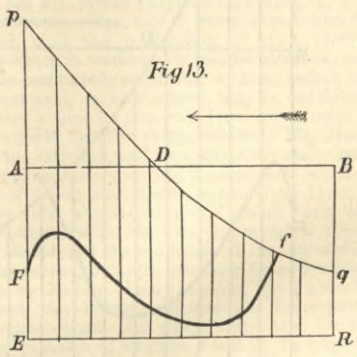


Fig 14.

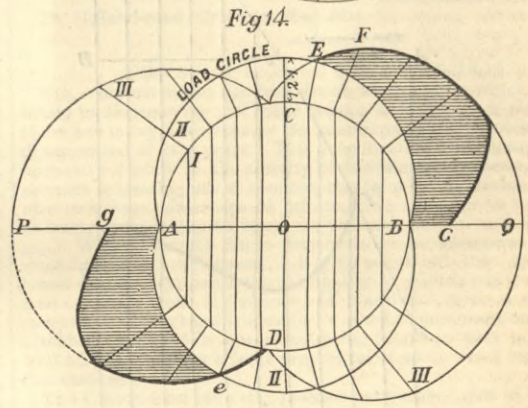


Fig 15.

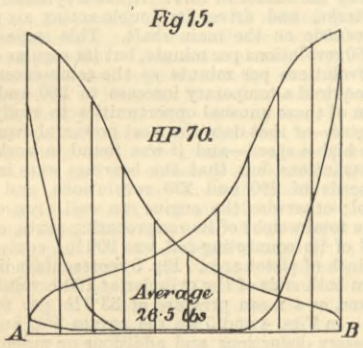


Fig 16.

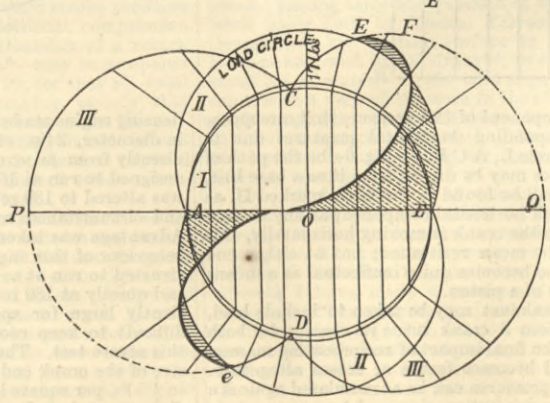


Fig 17.

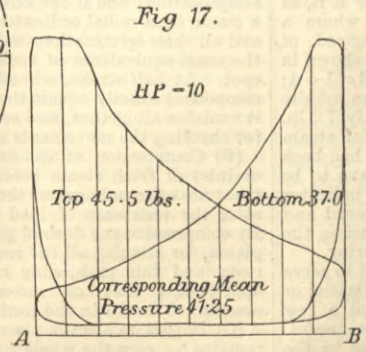


Fig 18.

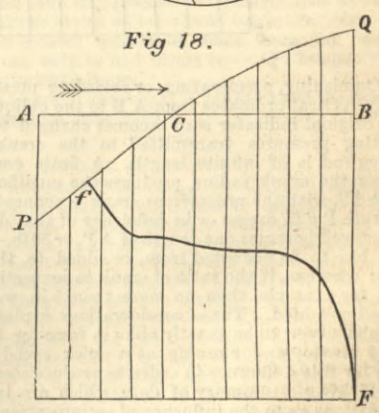


Fig 19.

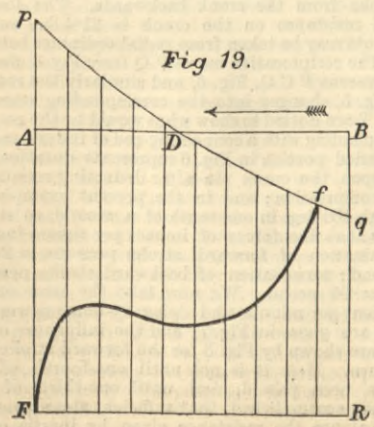


Fig 20.

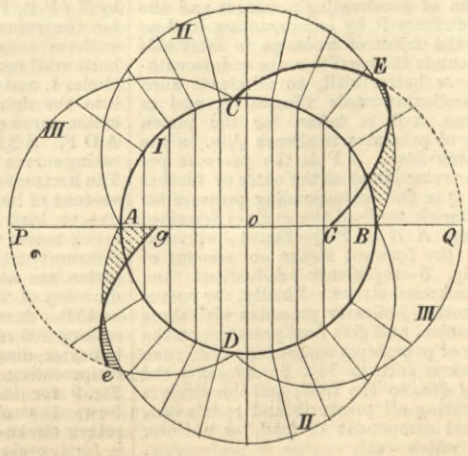


Fig 21

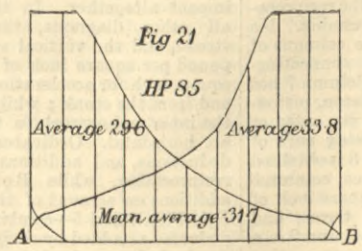
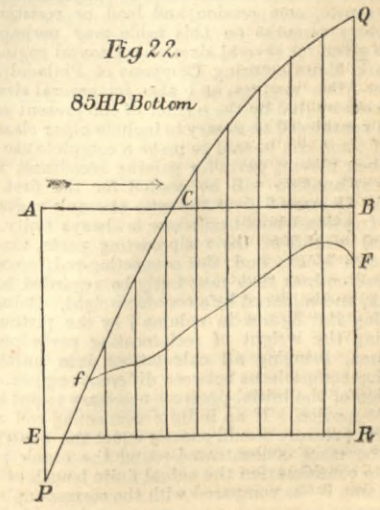


Fig 22.



from improper arrangements—not for criticism, but only as showing how the proportions may influence the quiet running of engines that make many revolutions per minute. Some diagrams given are thoroughly unsuited to quick-running engines, but they give useful instruction as to what ought to be avoided. These remarks also apply to diagrams taken from the author's own high-speed steam engines, and it is hoped that this paper may aid in the removal of many crude fallacies which disfigure engine-makers' catalogues, and mislead an ignorant public. It should also be explained that all original diagrams have been altered to one uniform scale of $\frac{1}{10}$in. per pound pressure, and to a uniform length, and all circles representing the crank path are to a scale of $\frac{3}{4}$in. to the foot. Irregularities due to oscillations of indicator pencils have been smoothed down, but no radical changes have been made in the original indicator cards.

The graphic diagrams used in the following paper are similar in general type to those invented by the author, and first published in January and April, 1870. They are used in his "Practical Treatise on the Steam Engine," and are fully explained there for those who wish to understand them. To show how valuable has been the assistance which engineers have gained from this graphic method of illustrating ± pressures on a crank pin, it may be mentioned that it was adopted by the present distinguished President of the Institution of Civil Engineers, Sir F. Bramwell, in his exhaustive paper on "Marine Engines," read at the Liverpool meeting of the Institution of Mechanical Engineers in July, 1872, and it is now used by engineers generally all over the world. This method replaces very troublesome mathematical calculations, such as few can be expected to remember for long after the completion of their academical studies, much less to undertake in addition to their ordinary labours. An ideal indicator card, A D G R S P, is shown by Fig. 1, and 30 lb. of its initial pressure of 60 lb. per square inch is required for overcoming the inertia of its reciprocating parts, transferred as 30 lb. to the further end of a stroke as a measure of resistance needed to restore these reciprocating parts to a state of rest. Diminishing, accelerating, or retarding pressures are represented by vertical ordinates from A B to the oblique line P Q, and thus the original indicator card becomes changed to P d F R E, as representing pressures transmitted to the crank pin, where a connecting-rod is of infinite length. A finite connecting-rod, of four times the crank radius, produces the modifications shown in Figs. 2 and 3, with the proportions crank ÷ connecting-rod = 1 ÷ 4; the pressure P p in excess or in deficiency of that due to an infinite connecting-rod becomes one-fourth of A P, or 30 lb.—namely, 7·5 lb. —which has to be deducted from, or added to, the initial steam pressure; whereas, if the ratio of crank to connecting-rod had been as 1 ÷ 6, for example, then no more than 5 lb. would have to be subtracted or added. These considerations explain why indicator cards ought never to be exactly alike in form for the forward and backward stroke, and running at a quick speed emphasises the necessity for this difference in order to produce steady driving.

Table II. gives a summary of data which are intended to serve for calculations as to the influence of reciprocating parts, initial or mean pressure, compression and load or resistance, and a few introductory remarks on this table may perhaps prove useful. Data are given for several sizes of horizontal engines made by the Southwark Manufacturing Company of Philadelphia, and known as Porter-Allen engines, and also for several sizes of high-speed engines constructed by the author of the present paper; but it has not been considered necessary to include other classes of engines, as so few of them can be said to make a complete use of the reciprocation of their moving parts for gaining steadiness in running. No special explanation will be needed for the first five columns of Table II. Column 6 gives the ratio of crank radius ÷ connecting-rod in a fraction whose numerator is always unity. Column 7 has the actual weights of the reciprocating parts, viz., piston, piston-rod, motion block, and the connecting-rod, except its outer or crank-head end, as that may fairly be regarded as being part of the crank, and balanced by a counter weight. Column 8 is obtained by dividing the figures in column 7 by the piston area, column 3 thus giving the weight of reciprocating parts per square inch of piston area, bringing all calculations into uniform terms, and facilitating comparisons between different engines. Column 9 is a calculation of the initial pressure necessary to put the reciprocating parts into motion. If an infinite connecting-rod were used, then this initial pressure would exactly equal the centrifugal force supposing the mass concentrated round the crank pin. Column 10 takes into consideration the actual finite length of the connecting-rod—column 6—as compared with the corresponding crank radius, and expresses how much pressure must be added to or deducted from the mean initial pressure on account of variations due to a finite connecting-rod. Column 11 expresses the actual initial pressures required for acceleration or retardation of the reciprocating parts at the end of cylinder furthest from the crank. Column 12 gives corresponding data to column 11 for the cylinder end nearest the crank.

Great divergencies will be noticed in the proportions of these engines in accelerating pressures required, and in their weights of reciprocating parts relatively to their piston area, and it will be apparent that no uniform rule can have been observed during their design in relation to such strains as arise from reciprocation. The necessity for providing sufficient initial steam pressure is pretty generally understood, and we do not intend to notice this matter in the present paper; but less consideration seems to have been devoted to those heavy strains which arise at the conclusion of each stroke, and which sometimes convert a steam engine into a steam hammer, working its own destruction.

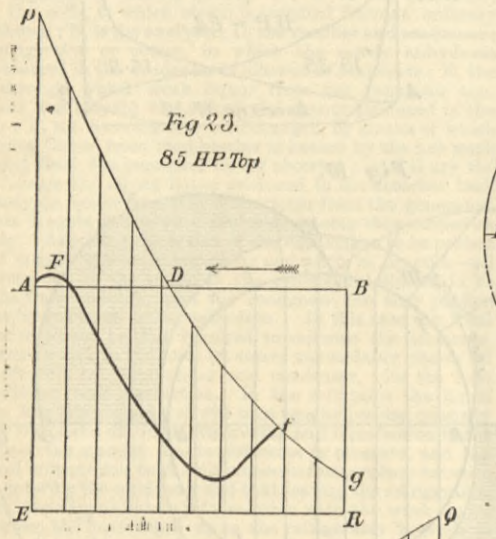
It is to a consideration of these final pressures that we propose to apply and extend the circular pressure diagrams, so as to render them easily calculated, and to show at a glance how much resistance is needed for retarding the reciprocating parts, and for bringing them quietly to rest. There are three elements by which such resistance can be offered, namely—A, the load upon an engine; B, compression of exhaust steam (and lead); C, impact on the crank pin; and of these three, impact on the crank pin alone tends to act destructively, and must be limited by load and compression within such degrees as may be found practically convenient in any given type of engine.

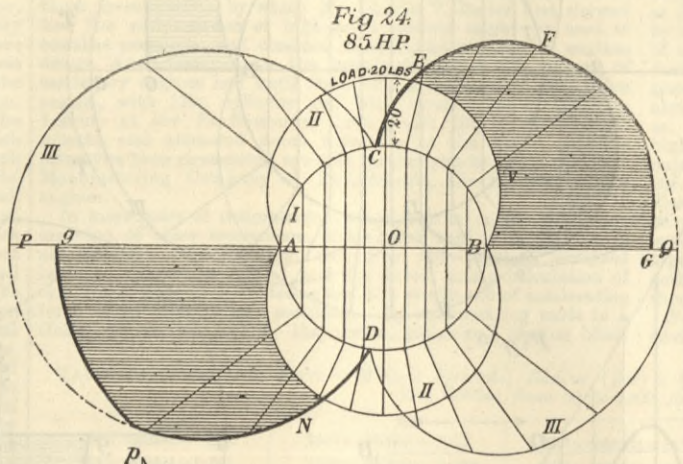
(A) The load or resistance on an engine may be considered as a uniform tangential pressure against the movement of its crank, and is measured upon the piston as the mean pressure given by an indicator card. Measured on the crank, this pressure diminishes in the ratio of two diameters to a circumference, thus—

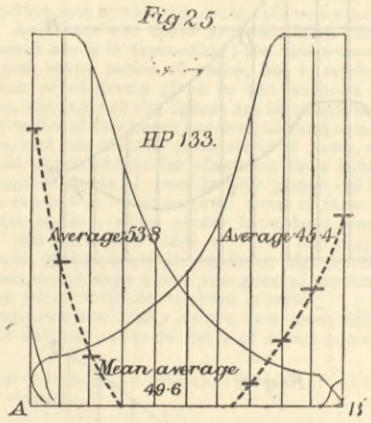
$$\text{Mean tangential load on crank} = \frac{2 \times \text{mean pressure}}{3{\cdot}1416}.$$

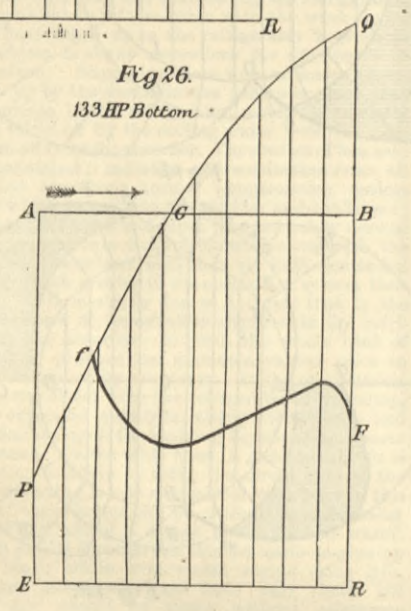
square inch of piston area. Circles III. are the curves P Q and q p translated into radial ordinates upon the circle A C B D as a base line, and they show graphically how much pressure is needed at any given position of the crank to counteract the influences of reciprocation; A P being for the extreme outer end, and B Q for the extreme inner end, thus corresponding with the indicator diagrams. Portions of crescents are cut off between circles II. and III., and C E B shows exactly how much of the reciprocation may be counteracted by horizontal components of the load or resistance, and E Q B shows how much remains to be dealt with by compression, or impact, or both; similarly, at the termination of a return stroke, D e A is resistance offered by load, and e P A remains over to be dealt with by compression of exhaust and impact against the crank. This opens up the question of valve setting, and its importance cannot be exaggerated; for upon correct proportions of clearances and compression depends the quiet, easy running and durability of any given high-speed steam engine. Compression curves taken directly for such indicator diagrams as Fig. 3 have been translated into their equivalents in circular diagrams such as Fig. 6, and appear there as irregular crescents, measured from circle III. as base lines. Thus F Q G corresponds with the termination of a forward stroke, and e P g corresponds with the termination of a return stroke. These have to be deducted from the reciprocating pressure circles III., so that finally there are left areas E F G B and e g A, which are shaded by horizontal lines, these representing the duration and amount of whatever strains have to be resisted by the crank and tend to its destruction. The area enclosed by E F G B—Fig. 6—gives the duration and amount of pressure accumulated at the termination of the forward stroke, and e g A represents corresponding lines and pressures for return stroke. Having secured all this information, it is easy to calculate the strains to which any given engine is subjected, and to understand why one may work well and another indifferently.

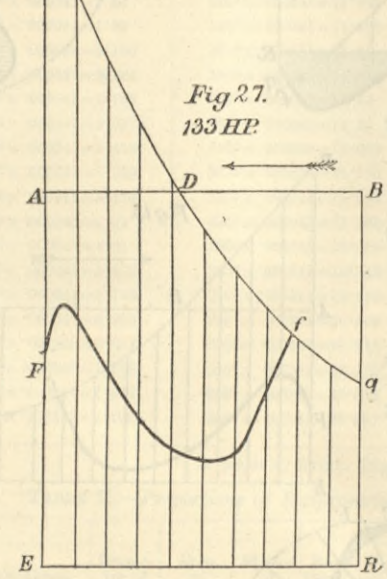
Our first illustration is taken from a powerful horizontal con-

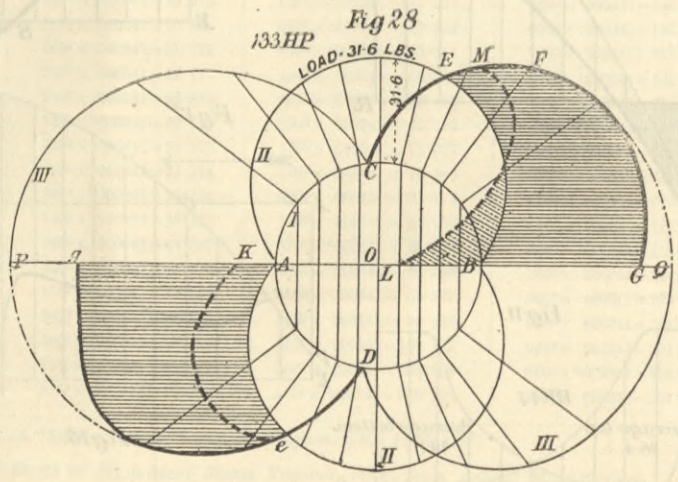












It is only the horizontal component of this pressure that can oppose a resistance against corresponding horizontal pressures due to reciprocation; and if the circle I., A C B D—Fig. 6—be the path of a crank, then radial ordinates may be drawn from it as a base line, and all their terminations will be found in the circle marked II. as the exact equivalents of such horizontal component at any desired spot. At half-stroke, when the crank is moving horizontally, this component exactly equals the mean resistance; but at either end it vanishes altogether, and so becomes quite ineffectual as a means for checking the movements of a piston.

(B) Compression of the exhaust may be taken to include lead, or inlet of fresh steam before a crank turns its centre; for both these are effectual against the final impact of reciprocating masses, after the resistance of load becomes feeble or ceases altogether. By compression any desired pressures can be accumulated against a piston, for bringing all the reciprocating masses, however great, to rest; and this cushioning of an elastic vapour to a pressure approaching that of incoming steam serves also important economical results in the working of steam engines.

(C) Impact on a crank pin results from whatever final difference remains between the whole sum of accelerating pressures and the deductions that have been made from it by counteracting load or compression, and it should be the object of a design to limit this pernicious action within the bounds that surfaces can endure without expelling the lubricant; or better still, to eliminate such impact altogether. In the indicator cards illustrated, and in all other diagrams, the line A B is taken for the piston stroke, and the vertical scale of pressures is always $\frac{1}{10}$in. to the pound per square inch of piston area. A P is the pressure per square inch for acceleration, or retardation at the outer or further end from the crank; while B Q is the corresponding pressure for the inner end nearest to the crank, and all the engines described are horizontal. Ordinates from A B to P Q—Fig. 4—represent deductions, and additions for the forward stroke on account of reciprocation, while B q—Fig. 5—represents deductions and additions on account of the backward stroke. Finally, the curves F f—Figs. 4 and 5—combine actual indicator pressures with those deducted or added by reciprocation, and give final pressures on the crank-pin in standard measure of pounds per square inch upon each piston. Circle I. in all diagrams such as Fig. 6 represents the path of a crank to a scale of $\frac{3}{4}$in. to the foot; and this circle is used as a base line for measuring all pressures and resistances. Circle II. gives the horizontal component of load, or uniform resistance, due to the work which each engine is performing, measured at any point as a radial ordinate to a scale of $\frac{1}{10}$in. per

densing engine made by the author in 1877. It has a cylinder 16in. in diameter, 24in. stroke, and drives its double-acting air pump directly from an excentric on the main shaft. This engine was designed to run at 160 revolutions per minute, but its regular speed was altered to 180 revolutions per minute at the commencement, and circumstances required a temporary increase to 200 and 220. Advantage was taken of these unusual opportunities to study the behaviour of this engine—at that date the most powerful ever constructed to run at so high a speed—and it was found to work well and quietly at 180 revolutions, but that the bearings were insufficiently large for speeds of 200 and 220 revolutions, and were difficult to keep cool; otherwise the engine ran well even under this severe test. The total weight of its reciprocating parts, exclusive of the crank end of its connecting-rod, was 900 lb., equivalent to 4·5 lb. per square inch of piston area. Fig. 3 represents indicator diagrams taken from both ends of the cylinder at 180 revolutions, giving 147-horse power, or a mean pressure of 33·6 lb. per square inch on the piston. In Figs. 4 and 5 we see curves P Q and p q pourtraying the necessary deductions and additions on account of reciprocation, while crank pressure diagrams are distinctly shown by E f F R, Fig. 4, for the forward stroke, and by R f F E, Fig. 5, for the return stroke from the crank backwards. The load or uniform tangential resistance on the crank is 21·4 lb., and its horizontal components may be taken from radial ordinates between circles I. and II. The reciprocation curve P Q from Fig. 4 changes into the double crescent P C Q, Fig. 6, and similarly the reciprocation curve q p, Fig. 5, changes into the corresponding crescents A D P. S S and T T are dotted to show what would be the reciprocating curves corresponding with a connecting-rod of infinite radius. The horizontally shaded portion in Fig. 6 represents duration and amount of impact upon the crank pin after deducting resistances due to load and compression; and in the present example the crank moves through 108 deg. in one-tenth of a second, so simple measurement shows that the forces of impact per square inch of piston are at termination of forward stroke pressure = 20 lb., duration = ·05 second; termination of backward stroke pressure = 15 lb., duration = ·05 second. We now take the same engine making 200 revolutions per minute and doing 84-horse power; its indicator diagrams are given in Fig. 7, and the influences of its reciprocating parts are shown by Fig. 8 for the forward stroke and Fig. 9 for the return. Here it is not until one-fourth of the forward stroke has been passed, and until one-third of the return stroke has been accomplished, that sufficient steam pressure is forthcoming to balance the resistance given by inertia of its piston, &c. Fig. 10 shows what is occurring at the termination of

each stroke; a very feeble horizontal resistance is offered by the load circle, and the amount of compression proves quite inadequate for bringing the rapidly moving masses to rest. Under these conditions the engine could not possibly work in the quiet and easy manner which its slower speed of 180 and its higher power rendered apparent. Here the crank moves through 120 deg. in one-tenth of a second, and the impact forces are for end of forward stroke pressure = 37 lb., duration = ·06 second; for end of return stroke pressure = 33 lb., duration = ·04 second. In order that this engine shall work well and quietly at 200 revolutions the initial pressure should be increased to not less than 80 lb. per square inch, the load about doubled, and the exhaust closed much earlier to provide sufficient cushioning that may bring about a state of rest at the end of each stroke.

Figs. from 11 to 16 illustrate the running conditions of an 11½in. by 20in. Porter-Allen engine making 230 revolutions per minute and producing 44-horse power with diagrams Fig. 11, or giving 70-horse power with diagrams Fig. 15. The ± pressures due to reciprocation are given by Figs. 12 and 13, and though they show no absolute deficiency of propelling pressure, yet its margin is perilously low at four-tenths of the return stroke; and although a fair average resistance is given by the load, yet the compression is insufficient. By methods already explained, the circular diagram Fig. 14 is constructed and measured, it shows the mean impact on its crank in terms of pounds per square inch. For end of forward stroke, pressure = 18 lb., duration = ·05 seconds; for end of return stroke, pressure = 25 lb., duration = ·04 seconds. If we now turn to the indicator cards Fig. 15, and corresponding circular diagram Fig. 16, these show the same engines still making 230 revolutions per minute. But a very great change has come about. The forces of impact have practically disappeared, and have been actually reversed by an excessive compression shown on the indicator cards. This remarkable illustration shows how completely the dynamical relationships of high-speed steam engines are under the control of the engineer, when once their principles have been thoroughly investigated and understood.

Figs. 17 to 20 inclusive are taken from a very successful high-speed engine made by the author, having a cylinder 14in. diameter, a stroke of 21in., indicating 104·7-horse power, and making 154 revolutions per minute. The degree of compression was very carefully proportioned to the weight of reciprocating parts, and therefore Fig. 20 shows an absence of those destructive forces so conspicuously present in Figs. 10 and 14. This satisfactory result has been accomplished without overdoing the compression, as in Fig. 16, and notwithstanding its heavy load, this non-condensing engine has worked regularly since 1880 in a satisfactory manner, and, moreover, with marked economy in fuel. Of late years an opinion seems to have grown up that because small high-speed engines can run with satisfactory results at speeds exceeding 200 revolutions, therefore the same engines may be driven far faster with equal success. This opinion has partly been fostered by the requirements of electrical engineers, and has led to a series of disasters of a character most discreditable to our national reputation for engineering skill. No data are forthcoming by which graphic diagrams similar to those we have already seen can be constructed for innumerable agricultural engines that have broken down under the absurd conditions of their work. Similar severe tests have been given to American engines of a far stronger and more scientific construction, and an example is given by Figs. 21 to 28 inclusive, from an 11in. by 16in. Porter-Allen engine, making the extremely high speed of 350 revolutions per minute; and driving a dynamo direct. Fig. 21 represents indicator cards showing 85-horse power, and Figs. 22 and 23 are corresponding crank pressures transferred as portions of circles marked III. in Fig. 24. Here the forward stroke—Fig. 22—receives insufficient pressure for giving motion to its reciprocating parts until one-tenth of its travel has been accomplished, and the final strains also are irregular and extremely heavy. Under such conditions it would be surprising to find the engine working easily, and the construction of a diagram Fig. 24 shows an excessive strain coming on the crank pin. For the end of forward stroke pressure = 40 lb., duration = ·05 second; for the end of backward stroke pressure = 52 lb., duration = ·025 second. The indicator cards, Fig. 25, show the same engine still making 350 revolutions per minute, but doing 133-horse power. Here the crank pressures become more regular, the load counteracts a greater proportion of the impact strains; but the amount of compression remains wholly inadequate to produce quiet and easy running. Here the remaining pressures are as follows:—For the end of forward stroke, pressure = 32 lb., duration = ·03 second; for the end of backward stroke, pressure = 44 lb., duration = ·025 second. In neither of these cases can this engine be expected to run well, and the means of cure are obvious from these diagrams at a glance.

By way of further illustration, it may be assumed that this engine has its valves reset so as to increase the amount of compression to that shown by Diagram 15, and for our present purpose we may neglect the increased mean pressure thus required to maintain 350 revolutions and to give out 133 indicated horse-power. The results of this change are shown by additional curves drawn upon Diagram 28 and terminating at K and L. Here compression at the end of a forward stroke produces everything that can be desired, but a little additional compression might advantageously be employed at the termination of a return stroke. The curve terminating at L—Fig. 28—may be compared with those terminating at G and *g* in Fig. 20, for they all fulfil some of the conditions of perfectly quiet running, namely, that any forces given out by the reciprocating parts towards the conclusion of a stroke, as shown by shaded portions, should be met and counterbalanced by more than an equivalent resistance required for compression. This insures relief from an evil which accompanies high-speed engines, namely, irregular load.

Reverting to Diagram 20, and assuming the load circle II. to approach closely to the base circle I., then, if an automatic governor be used to vary the rate of expansion, we should find that diagrams like 8 and 9 would be produced where there is not enough steam pressure to give the necessary acceleration, and we should also find that the points E and *e* would closely approach *c* and D, thus leaving a large margin of unresisted forces to become a destructive impact upon the crank pin. Such diagrams as these afford an unerring guide to the designer of any high-speed steam engine, for, after deciding upon its dimensions, speed, and intended range of power, such diagrams as Fig. 28 can be constructed so far as circles I., II., III. are concerned; then radial ordinates can be transferred from this preliminary or trial diagram back to indicator cards, like Fig. 25, where their terminations will display compression curves, such as are shown by dotted lines on that figure. It also follows, as a matter of course, that similiar investigations may be taken from any existing engine in order to discover the proper place where compression should begin; and if the designer cares to be perfect in every way, he can thus very readily find out how much clearance spaces should be allowed. It is a common error to imagine that the reduction of such spaces to a minimum is an unmixed gain in the case of high-speed steam engines, nor should it ever be alike at both ends of a cylinder. Judging by these examples, all taken from engines in actual work, it cannot be a matter of any surprise that contradictory results are obtained from high-speed engines. Indeed, there are many other engines not avowedly of a high-speed character, but often of considerable size, and these give immense trouble through heating of bearings and other pernicious habits. If the engineers in charge would only take the trouble to weigh the heavy masses which are kept in comparatively rapid motion—if they would select indicator diagrams and lay bare the whole secret history of their charge in one revolution of its existence by the use of these new diagrams which the author hopes may prove interesting and useful to his fellow-engineers—then there would be no difficulty whatever in ascertaining what changes are necessary to remove the evils experienced so frequently. The working days of their engine would be passed in quietude, its life prolonged, and their own anxieties in no small measure diminished.

LETTERS TO THE EDITOR.

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

40-KNOT SHIPS.

SIR,—Some sixty years ago a distinguished French savant, the late M. Rèech, advanced a certain hypothesis, from which it necessarily follows if we have two unequalised vessels of the same type, and similarily immerged, denoting a lineal dimension, speed, power, and Admiralty coefficient, of the smaller and larger vessels, by the significant letters *l*, *v*, *e*, *c*, and L, V, E, and C respectively, that the following relations must exist between these quantities.

(1) $c = C$; that is to say, the Admiralty coefficients will have the same value.

(2) $\frac{E}{e} = \left(\frac{L}{l}\right)^{\frac{7}{2}}$. The power for the speeds *v* and V in the respective vessels will be in the ratio of the seventh power of the square roots of their lineal dimension. What is the involved hypothesis? In the first place, $c = \frac{l^2 v^3}{e}$, and $C = \frac{L^2 V^3}{E}$, is the supposition by which the quantities known as the Admiralty coefficients are determined, and the first condition, $c = C$, implies, $\frac{l^2 v^3}{e} = \frac{L^2 V^3}{E}$, whence, obviously, $\frac{E}{e} = \frac{L^2 V^3}{l^2 v^3} = \left(\frac{L}{l}\right)^{\frac{7}{2}}$ (by the second condition, as above), and by simplifying $\frac{V^3}{v^3} = \left(\frac{L}{l}\right)^{\frac{3}{2}}$ whence, by extracting the cube root of both members, we obtain—

(3) $\frac{V}{v} = \left(\frac{L}{l}\right)^{\frac{1}{2}}$. Consequently, Rèech's hypothesis implies similar and similarly immerged vessels, driven at speeds proportional to the square roots of their lineal dimension will satisfy the three conditions noted.

Lately some letters have been published in THE ENGINEER which illustrate this. A torpedo-boat—110 × 12 × 6·25 draught, displacement 52·5 tons—is stated to have been propelled 21·75 knots by 470 indicated horses; in which case the Admiralty displacement coefficient would be

$$c = \frac{(52{\cdot}5)^{\frac{2}{3}}\,(21{\cdot}75)^3}{470} = 307.$$

For the hypothetical case of a similar vessel of three times the lineal dimensions—that is to say 330 × 36 × 18·75 draught, displacement 1417·5 tons, by the second condition we should have

$$E = 470\left(\frac{330}{110}\right)^{\frac{7}{2}} = 22{,}000 \text{ indicated horses;}$$

by the third condition we have

$$V = 21{\cdot}75\left(\frac{330}{110}\right)^{\frac{1}{2}} = 37{\cdot}68 \text{ knots;}$$

and the Admiralty coefficient:

$$C = \frac{(1417{\cdot}5)^{\frac{2}{3}}\,(37{\cdot}68)^3}{22{,}000} = 307,$$

confirming the first condition.

In your issue of the 7th May I notice Mr. Paulson, by his reading of Rèech's hypothesis, deduces 12,690 indicated horses, instead of my figure 22,000, and, consequently, the displacement coefficient 307 would then attain the somewhat extraordinary magnitude 532·3, which is about double the value attained in large full-powered vessels: for example, the Cunard Umbria with her 14,500 indicated horses on trial! Other circumstances not touched upon render calculations at these high speeds altogether illusory; and, in my opinion, whether in the form proposed by M. Rèech, or, as afterwards adopted by the late Dr. Froude, this hypothesis in an entirely mistaken reading of experimental facts, and of the principles involved in the problem of steamship propulsion.

ROBERT MANSEL.

White Inch, Glasgow, June 1st.

SIR,—I am pleased to see Mr. Hurst purposes favouring us with a detailed description of these ships, and I must thank him for having at last admitted that the production of such vessels, instead of being a result which is well-known can be attained, and the power required easily computed, as stated by him before the Society, is rather problematical, or, at the best, may be considered probable. Within so short a time he descends from certainties to probabilities. May we expect further retrogression? Mr. Hurst considers he has caught me tripping, and denounces my statements as utterly absurd, at the same time drawing a conclusion which is not the necessary result of those statements, considering them in their special relation to ship propulsion, and I think I can, to a certain extent, maintain them with his own arguments. I may inform him that I have considered the reduction of heating surface attending increased horse-power, but also consider there is a limit to that reduction, which we have probably touched upon already. Taking my ground upon the heating surface per horse-power obtained in first-class torpedo-boats and other ships, and for the present leaving aside the question of weights, I find in the torpedo-boats lately built by Messrs. Yarrow and Co. for the Austrian Government the heating surface to be about 1·4 square feet per horse-power, with forced draught, at a pressure in the stokehole of about 5in. of water. In the trial trips of several of our first-class ships, with a varying pressure in the stokehole, the heating surface per horse-power was from 1·44 to about 1·8 square feet. Finding so close an agreement in such different types of ships, I think I am justified in considering we have almost reached the lowest limit for heating surface.

Now, if Mr. Hurst had taken the trouble to calculate the surface of the eighteen boilers which I considered necessary to develope the required power, he would have found it to be about 1·5 square feet per horse-power; and as he confesses that the boilers of first-class torpedo-boats are overtaxed, I fail to see wherein I have made a mistake. Again, the low proportion obtained in these torpedo-boats is, as stated above, with a pressure in the stokehole equal to 5in. of water. Possibly Mr. Hurst does not consider the human element of any importance, or believe the men suffer under such pressures; but if he would interview some of those who have been on a trial trip where the pressure was only equal to 2in. of water, he would learn it is nothing uncommon for some of the stokers to be carried on deck completely exhausted. Under such circumstances, it would be impossible to work on a voyage across the Atlantic at a speed of 40 knots, and as proposed by Mr. Hurst; so that I think I have reduced my proportions as far as possible. Mr. Hurst tells me that the weight of boilers is proportionate to the heating surface. Well, I find that in our first-class ships we obtain from 15 to 20-horse power per ton with a heating surface of from 1·8 to 1·5 square feet per horse-power with forced draught; and as he says engines and boilers are at present constructed subject to the above rule, which he subscribes to, I think he cannot consistently find fault with the weight of boilers and fittings which I allowed, viz., 1500 tons, equal to 24-horse power per ton, and with a natural draught. On the whole, I think the only mistake I may have made, so far as the boilers are concerned, is in approaching too closely to Mr. Hurst's theories. The weight of these boilers, added to that of the coals and hull, equal a draught of 28ft.—*i.e.*, 3ft. over the draught allowed.

Turning now to the weight of machinery, which will be understood to mean not merely the main engines, but auxiliary machinery also. I allowed their total weight to equal two-thirds that of the boilers. If Mr. Hurst will remember that his large vessels must necessarily carry more and heavier auxiliary machinery than a torpedo-boat, he may admit that I have not made my machinery too heavy. He admits we cannot use small and high-speed engines, therefore we are obliged to have recourse to large ones, and, owing to a limited piston speed, slow running ones. The machinery of the Trafalgar is equal in weight to the boilers. This weight I have reduced to two-thirds in my letter, thereby allowing 33 per cent. as a margin for all possible improvement, and supposing it to be possible to reduce the number of auxiliary machines. Is it to be supposed that the leading engineers in this country are making their boilers three times as strong as is necessary for safety, and that they add the same amount of useless weight to their engines, merely "for the fun of the thing?" If this can be said of those who build boilers and engines for the Royal Navy, where lightness is a serious consideration, what is to be said of those engineers who have made our merchant navy so famous, when their weights per horse-power averages twice that of the Royal Navy?

Mr. Hurst supplies a key to the whole affair when he states, "The superiority of large over small engines, other things being equal;" but I cannot see wherein other things are equal, and think he somewhat confounds the various elements and conditions to be taken into consideration. He says it is the high piston speed of torpedo-boat engines which allows them to be so light. I believe the piston speed of these engines is very little more than that of many large yet heavy engines. If he had two hulls of exactly equal proportions, and with equal propellers, and placed in these hulls engines capable of developing the same horse-power at the same piston speed, but with very different strokes, does he suppose that when running at the same piston speed the "other things" would be equal? He appears to forget that experiment has shown us there is a limit to the proportion of propeller pitch to diameter—that with a given horse-power we have to consider whether it can be utilised with the limited sizes of screw, and that, on the other hand, there is also a limit to piston speed, although he does not take this into consideration at all, as he says, "The engines of the Trafalgar, if placed in a hull which they could drive at three times the existing speed;" and "if the speed of a light vessel was quickened from twenty to forty knots;" and again, "My engines will be faster than torpedo-boat engines." If the engines of the Trafalgar were placed in a light vessel, as we are limited to the sizes of screw, the only result would be the engines would race away, and as it is supposed that piston speed has a limit, and engines are constructed to run at the best speed developing their full power, the steam would have to be throttled to reduce the revolutions; so that we would have engines capable of great power working far beneath their capabilities—the conditions under which Mr. Hurst's engines would be working, only more so. The torpedo-boat engines could not be quickened to drive the vessel from twenty to forty knots because of this piston speed. With regard to Mr. Hurst's engines, as they must be large ones, with a considerable stroke, and are to run faster than torpedo-boat engines, I presume they will have a piston speed of 4000ft. or 5000ft. per minute. I cannot understand his statement, "It is a high speed of hull which permits of a high speed of piston." It appears to me to be somewhat "end for end."

My contention is, that being of necessity obliged to use large engines of considerable stroke, and slow-running, owing to a limited piston speed, we cannot reduce the number of boilers, their weight, and the weight of engines much below what engineers at present find necessary; that, bearing in mind we have a limited number of revolutions, and also a limited diameter and pitch of screw, we probably cannot obtain gear capable of driving a vessel 40 knots, although we can, and will, exceed the present speeds; and that, going upon the proportions of first-class torpedo-boats, the weight of the boilers necessary for the power, added to the weight of coal and hull, is more than equal to the draught allowed. It cannot be done. Perhaps Mr. Hurst may see a way out of all the difficulties which I have suggested; if so, and if he can produce his vessel and drive it at 40 knots, he will accomplish a feat compared to which all other engineering wonders will fade in insignificance.

I may add I have not time to carry on this discussion by correspondence, the subject being rather apart from my ordinary work, but am willing to continue it where it commenced, viz., at the Society; and I would like to see the subject taken up by some of our authorities on such questions, when young members of the profession like myself could listen and learn.

ROBERT G. BLEASBY.

13, Upland-road, Croydon, May 31st.

GERMAN OPINION OF SCOTCH PIG IRON.

SIR,—My attention has been drawn to an article which appeared lately in *Engineering* and other papers, in which it is stated that there are many assertions by German experts that Scotch iron has deteriorated of late years. This deterioration is attributed by the authority quoted to the scarcity of blackband ironstone, and consequent increasing use of common clayband in the Scotch furnaces, also to a large admixture of mill and forge cinder—in some cases, at least, degrading good brands to the rank of the so-called cinder pig. Whatever truth there may be in these assertions so far as some brands are concerned, I beg to point out that the Carron brand exactly represents the old quality of Scotch pig iron, as it is made entirely from the richest old blackband, with a very small proportion of clayband ironstone—worked in combination with the blackband seam—this admixture being found to give a soft iron, well adapted to carry a large proportion of scrap when remelted for fine castings.

The Carron Company still possesses extensive fields of blackband ironstone, so that the brand will continue for a long time to come to be of the old Scotch quality as made from the finest ores. Carron pig iron can only be had direct from the company or from the specially authorised agents.

(For Carron Company) DAVID COWAN, Manager.

Carron, Stirlingshire, May 26th.

A DEGREE IN ENGINEERING.

SIR,—In your issue of the 21st ult. I see that at last the Senate of the University of London are about to establish a degree in "Engineering Science." Many students and members of the profession will doubtless enter for it, but to the majority the comparatively stiff matriculation examination will be an insuperable barrier. Whilst, or after, serving their pupilage few can find time to pick up again their English and classics—more especially since different authors are set annually—to the satisfaction of the examiners, to engineers, the re-acquirement of these subjects is, for obvious reasons, practically a waste of both time and trouble.

In the interests of the profession, could you afford space to call the attention of those in authority to the desirability of dispensing with this matriculation examination, in the cases of candidates for the new degree in "Engineering?" Were this dispensation allowed, I am satisfied that the examination would be well attended; for although the London examiners are proverbially severe, they do not require that candidates shall have attended a preparatory course at one of their affiliated or other Colleges.

June 2nd. A STUDENT INSTITUTE C.E.

THE ELECTRIC LIGHT IN THE COLONIAL AND INDIAN EXHIBITION.

SIR,—Referring to your description of Messrs. Galloway's engines in last week's number, we should be glad if you could in any way call attention to the fact that the wide single endless driving belts used by this firm, both in the Garden engine-room and in the west quadrant, were made by ourselves, and are on the cemented joint principle, without hemp or lace sewing.

S. E. NORRIS AND CO.

London, June 2nd.

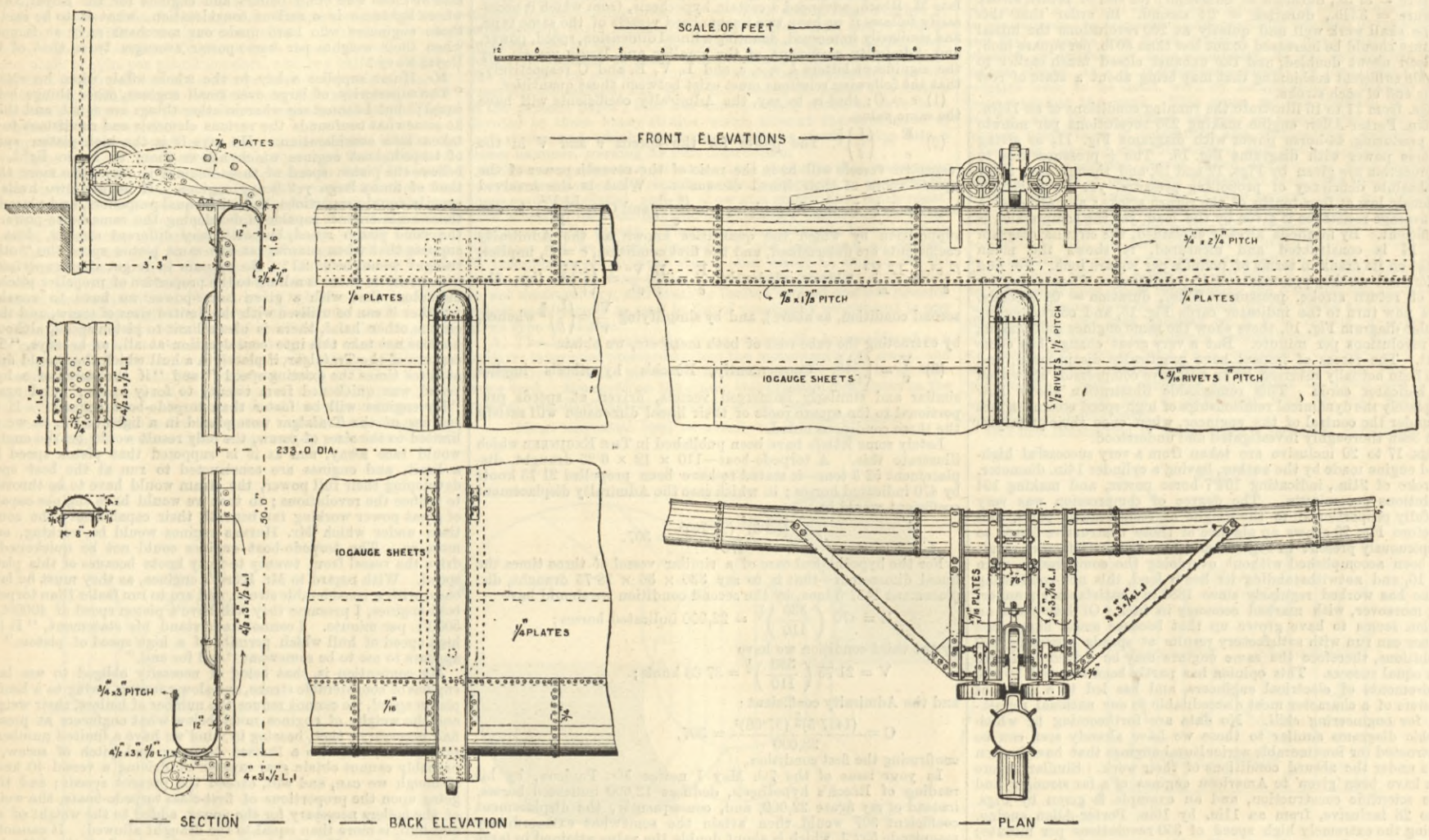
[We may add that these belts are beautifully made, very pliable, and even.—ED. E.]

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—John M. C. Bennett, to the Rattlesnake; James H. Gilbert, to the Cossack; George R. J. Cummings, to the Espiegle.

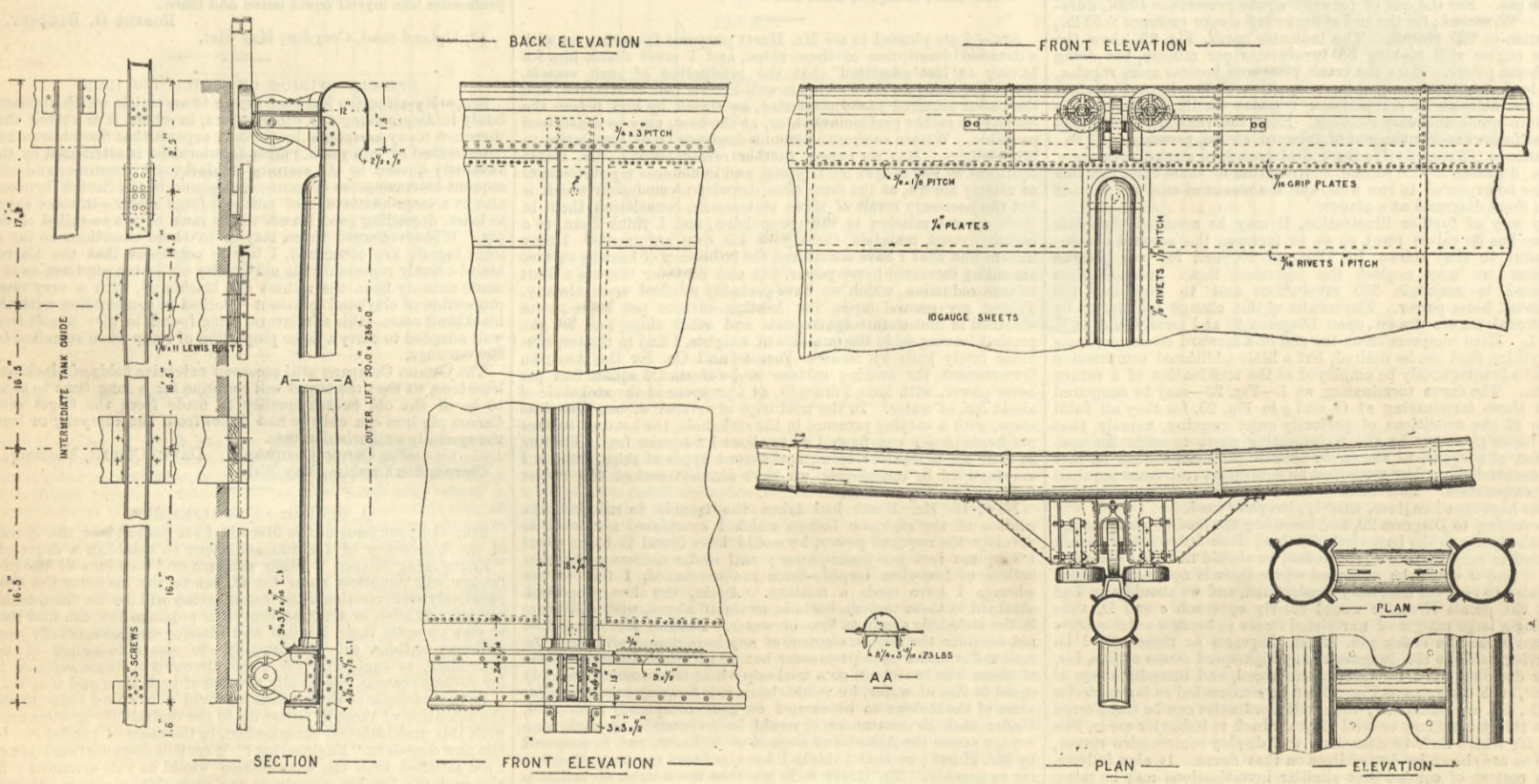
THE BIRMINGHAM GAS WORKS.—240FT. GAS HOLDERS.

MR. CHARLES HUNT, M.I.C.E., BIRMINGHAM, ENGINEER.

(*For description see page* 409.)



PLAN AND ELEVATIONS OF INTERMEDIATE HOLDER, JOINTS, GUIDES AND GUIDE ROLLERS.—GROUP 6.



PLAN AND ELEVATIONS OF PARTS OF LOWEST HOLDER, GUIDES AND ROLLERS.—GROUP 7.

BIRMINGHAM GASWORKS—240FT. GASHOLDERS.

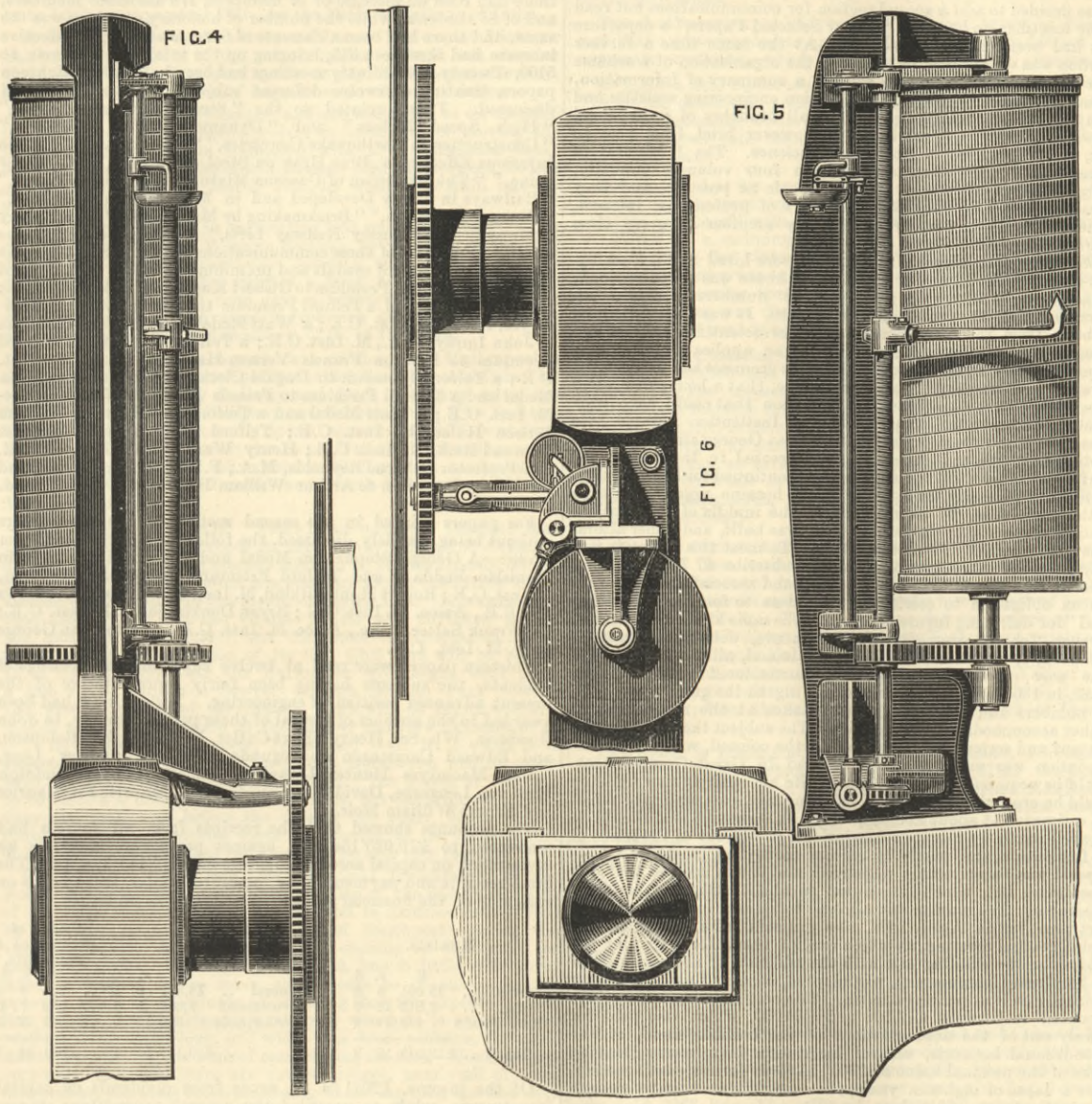
WITH the engravings which we publish above we complete the illustration of these great gasholders. It conveys little when we say that they are the largest in the world, and our engravings give an inadequate notion to any but the specialist of the dimensions and of the difficulties to be overcome in making so large a structure of very light scantling. The description which we published in our last impression gives the leading particulars of the work. A visit is necessary for those who would gain more.

ENGINEERING SOCIETY, KING'S COLLEGE, LONDON.—A meeting was held on Tuesday, May 25th, the president, Mr. W. N. Collis, in the chair, and a paper read by Mr. A. K. Peaty, entitled "Small Arms." The author first gave a condensed history of the gradual development of the gun, mentioning in order petronels, matchlocks, flintlocks, capping muzzle-loaders, and modern hammerless top lever guns. The manufacture of guns was then dealt with, the author showing how Damascus and laminated barrels were produced, and also the mode of boring cylinder and choke barrels, and method of rifling. Descriptions of cartridges followed, Kynoch's brass cases and the military "Boxer" and "solid-drawn" being specially mentioned. Various bullets in use, including the "Express," Lord Keane's cruciform, and Macleod's smooth-bore were shown and explained. Finally the Spencer and Winchester repeater rifles, the Soper and Field Snider rifles, the breech actions of Purdey, Anson, Deeley, Walker, and Long, and the ejecting mechanism and safety bolting of Westley, Richards, and Greener, were briefly described.

THE NATIONAL AGRICULTURAL HALL, KENSINGTON.—The roof which is being erected over the central portion of this building covering a space between walls of 440ft. by 250ft. was visited on Saturday last by the members of the Civil and Mechanical Engineers' Society and their friends. The party were conducted over the works by Mr. M. am Ende and Mr. A. T. Walmisley, by whom the ironwork has been designed, and who are acting as joint consulting engineers for its erection under the supervision of Mr. James Edmeston the architect to the National Agricultural Hall Company. Great interest was shown by the visitors in the pivotted columns which we illustrated on page 333 of our issue for April 30th last, and the general leading features were pointed out by Messrs. am Ende and Walmisley, who explained the drawings. We hope to give further detail and description as the work proceeds. The ironwork is being rapidly proceeded with by Messrs. Handyside and Co. of Derby, and the contract for the glass and zinc covering is to be upon Messrs. Helliwell and Co's patent system. At present three ribs, being the third, fourth and fifth main ribs from the west screen of the central roof, are completed, with intermediate ribs, and purlins, and the next or sixth rib is in course of erection. The roof is being erected by means of a travelling stage, containing about 10,000 cubic feet of timber, with commodious staircase and top platform 62ft. wide, about 70ft. above floor level. The main ribs being 34ft. centres, this platform extends 14ft. beyond the centre of each rib in each position for fixing the ironwork of the several bays. As an example of lightness combined with good architectural effect, the company is to be congratulated upon the effectiveness of the design, and the undertaking merits success.

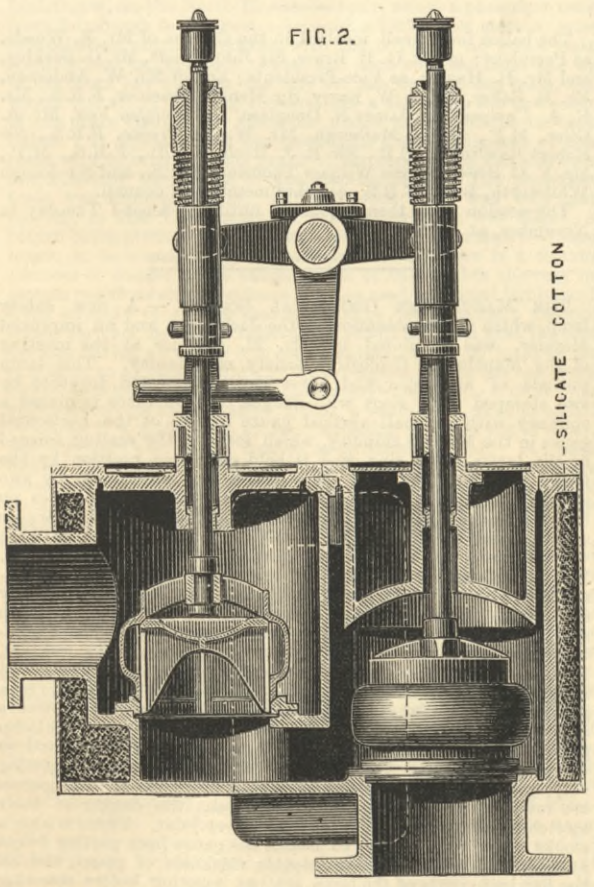
INDICATING GEAR FOR WINDING ENGINES.

CONSTRUCTED BY MESSRS. TANGYE, BIRMINGHAM.



WINDING ENGINES FOR THE AUSTRALIAN AGRICULTURAL COMPANY.

ON p. 416 of our last issue we gave a general view of a pair of winding engines, made by Messrs. Tangyes, of Birmingham, under the instructions of Mr. J. D. Baldry, M.I.C.E., for use in the extensive coal mines of the enterprising Australian Agricultural Company, New South Wales. Some six years ago Messrs. Tangye sent out to the same collieries a somewhat similar pair of hauling engines, which we illustrated on pp. 103 and 119 of our fiftieth volume. In speaking of these engines we pointed



out that the arrangement was in some respects a departure from general practice. It is interesting to find that the design has proved in all respects satisfactory, and that it has met with special approval from mining engineers in the colonies. The engines now under notice have steam cylinders 32in. diameter by 48in. stroke, and are steam jacketted, with separate steam pipes and valves for supplying the jackets direct from the main steam pipe. The steam and exhaust valves are of the Cornish type, double-beat equilibrium, two separate nozzle boxes being fitted to each cylinder containing these valves.

Fig. 2 represents one of the nozzle-boxes in vertical section, showing the Cornish double-beat valves. The steam valve is in section, and the exhaust in elevation. Both valves and seats are of gun-metal. The valve spindles are of steel, and are secured to the valves by means of a solid head and loose collar. On the upper ends of the valve spindles are cottered the lifting caps, which are fitted with steel wearing parts. The lifting levers are guided by cast iron cross-stays, brass bushed, and have oil cups fitted at top for lubricating the spindles. To insure the closing of the valves, light steel spiral springs are placed between the lifting caps and the cross-stays. The weigh shafts for working the valves are carried by cast iron cross-bars in gun-metal bearings. These cross-bars and stays are carried by four wrought iron turned pillars bolted to the nozzles. The weigh shafts, lifting levers, and connecting links are of wrought iron, with case-hardened wearing parts. Fig. 3 is the plan of the nozzle, showing the arrangement of the cross bars and stays.

The engine bodies are each in two parts, secured by bolts and cotters. The crank shaft is of Siemens-Martin steel, 10½in. diameter in the journals. The bearings are in three parts, and of gun metal, with wedges and screws for adjustment, and arranged that they can be removed without taking out the shaft. The hauling drums are 6ft. in

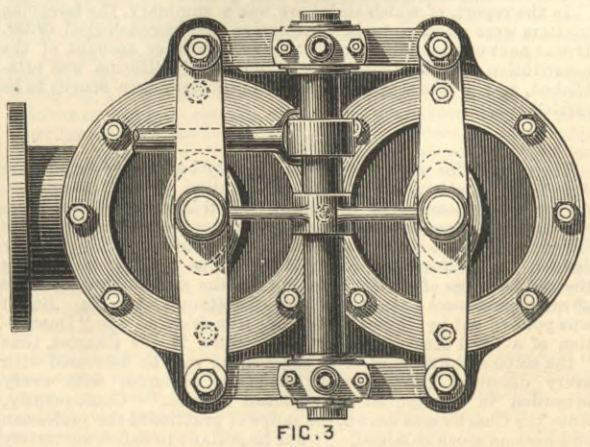
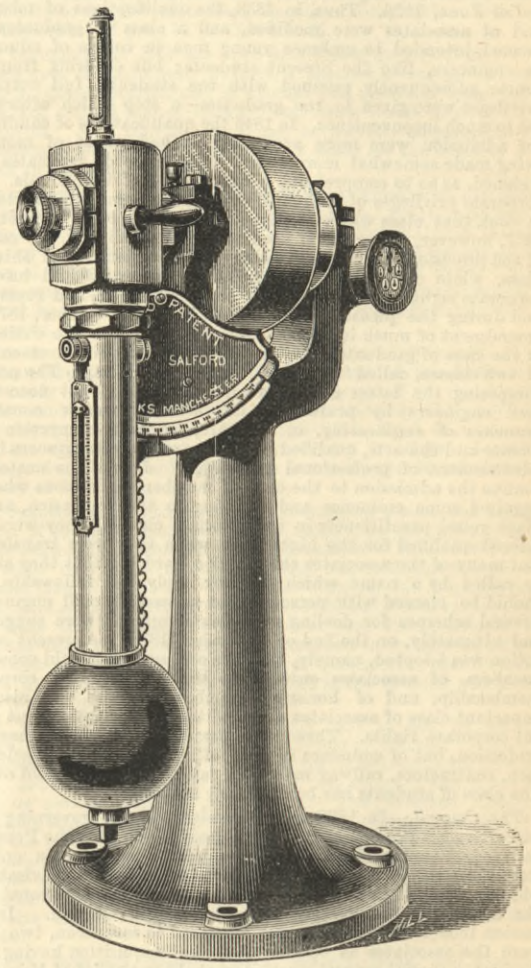


FIG.3

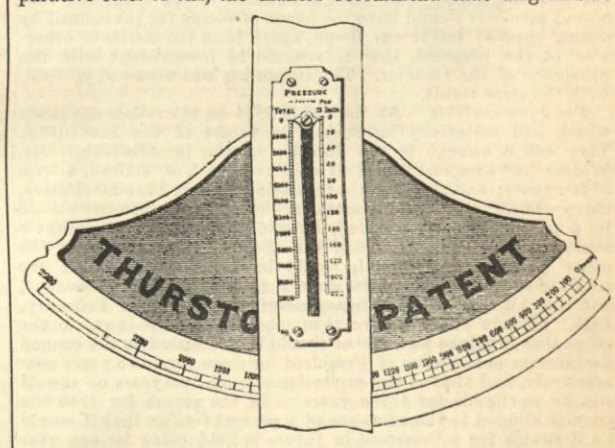
diameter and 3ft. wide, loose on the crank shaft, and driven by steel clutches. The flanges are of wrought iron, with lagging of timber 4in. thick. Each drum is provided with a brake fitted with oak blocks. A bearing is provided for carrying the centre of the crank shaft. Between the engines is fixed a raised platform of wrought iron, on which are placed the clutches, brake wheels, reversing lever, steam valve handle, and rods for working the condenser steam cocks. The engines, platform, &c., are all mounted on a strong cast iron bed plate, in six parts, planed and fitted together with turned bolts. As these engines are to haul about 2000 yards, they are fitted with an arrangement for indicating with accuracy the position of the tubs at any point in their journey. This is shown in Figs. 4, 5, and 6, and, as will be seen, consists of a vertical drum rotated by spur gearing, and having traced upon it a spiral line along which the positions of the various stations are marked. A pointer moving on a screwed shaft, driven by worm gearing from the main drum, traverses the spiral, and so indicates the position of the truck. The steam cylinders and nozzles are lagged with silicate cotton and covered with sheet steel. Large relief valves and steam traps and sight feed lubricators of Messrs. Tangyes' make are provided. These engines were tested with steam at the Cornwall Works, the reversing being accomplished with ease and facility. All the handles are in close proximity to the engine man. The speed of hauling is nine miles per hour, and about eighty skips of 10 cwt. each make up a load.

THURSTON'S PATENT OIL TESTER.

PROFESSOR THURSTON'S tester for investigating the qualities of lubricating oils is no doubt already well-known to most of our readers. Messrs. W. H. Bailey and Co., of the Albion Works, Salford, Manchester, who are the sole makers of this machine for Great Britain and the European Continent, have recently made one, of what may be considered as colossal dimensions, for the Belgian State Railways, the journal of which is of the standard car-axle size, that is, 3¼in. diameter and 7in. long. The



total maximum pressure which can be placed on the steps is 5 tons, this being about equal to 400 lb. on each square inch of surface exposed to friction. Readings of the arc or quadrant of the machine, and the number of revolutions required to deflect the pendulum when the lubricating properties of the oil are exhausted, as indicated by the thermometer on the top step of the journal, enable the experimentalist to determine the life of the oil and its lubricating value. In keeping a record of comparative tests of oils, the makers recommend that diagrams be



employed having columns set apart for (*a*) reading off the number of revolutions required to raise the temperature of the journal to 150 deg. Fah., (*b*) the deflection of the pendulum as indicated on the arc, (*c*) the co-efficient of friction, (*d*) and the cost in pence per gallon of the oil which has been tested.

Professor Thurston has also invented an autographic diagram recording iron tester, for torsional and tensile strains, and has also licensed Messrs. Bailey and Co., of Manchester, to be the sole European makers, a perusal of whose catalogue—Bailey's Testers—will be found to be interesting and instructive to all concerned in the scientific examination of materials of construction, &c.

ELECTRIC LIGHTING IN A TOBACCO MANUFACTORY. — Messrs. Mather and Platt have recently completed an installation of 700 lamps in the extensive new tobacco and cigar manufactory of Messrs. W. D. and H. O. Wills, Bristol. The building is lighted throughout by 16—20-candle power Swan lamps, and no gas has been laid on, except for heating purposes. Two 500-lamp Edison-Hopkinson dynamos, running at a speed of 700 revolutions per minute, have been supplied for this installation, either of which is capable of maintaining the whole number of lamps usually in use at one time.

ELECTRICAL PURIFICATION OF COPPER. — Messrs. Sir Hussey Vivian and Sons, of Swansea, about a month ago purchased from Messrs. Mather and Platt, through the Edison and Swan Company, one of the largest dynamos hitherto constructed for electrolytic purposes. It has an output of 50 volts 1000 ampères at a speed of 400 revolutions. The weight of the entire machine is 5¼ tons. The magnet limbs are solid forgings, each weighing 22 cwt., and are shunt-wound only, each limb having 260 lb. of copper wire. The armature is constructed of bars 0·338 square inch area, and has a resistance as low as 0·0016 ohm. The commercial efficiency of the machine is over 93 per cent. This dynamo has given such satisfaction that Messrs. Mather and Platt have recently received an order from the same firm for a second precisely similar machine.

THE INSTITUTION OF CIVIL ENGINEERS.

THE Annual General Meeting, to receive and deliberate upon the report of the council on the condition of the Institution, with the annual statement of the accounts, and to elect the council and officers for the ensuing year, was held on Tuesday, the 25th of May, Sir Frederick Bramwell, F.R S., the President, being in the chair. As fifty years had elapsed since a connected account had been given of the origin and progress of the Institution, it was thought not inopportune to submit a condensed narrative of the successive steps by which its present position had been arrived at.

HISTORICAL NOTICE.

The constitution had in the interval been gradually changed, for the purpose of rendering the bye-laws more definite and consistent with the Royal Charter of Incorporation, granted on the 3rd of June, 1828. Thus, in 1838, the qualifications of members and of associates were modified, and a class of graduates was formed, intended to embrace young men in course of education as engineers, like the present students; but differing from the course subsequently pursued with the students, full corporate privileges were given to the graduates—a step which afterwards led to much inconvenience. In 1846 the qualifications of candidates for admission were more accurately defined, those of members being made somewhat more strict, while those of associates were widened, so as to comprehend a larger range of individuals. The corporate privileges of graduates were at the same time curtailed; in fact, that class was virtually allowed to become extinct. In 1867, however, the class of students was established, the essence of the provisions then passed being that the members of this new class, while enjoying many special privileges, should have no corporate rights, and should only be admitted by, and remain at and during the pleasure of, the council. In December, 1878, an amendment of much importance took place. Since the extinction of the class of graduates, the Institution had consisted essentially of two classes, called "members" and "associates." The persons composing the latter class were defined to be "not necessarily civil engineers by profession, but whose pursuits constitute branches of engineering, or who are, by their connection with science and the arts, qualified to concur with civil engineers in the advancement of professional knowledge." It was the custom to confine the admission to the class of members to persons who had acquired some eminence and standing in the profession, and to place young practitioners in the associate class till they were considered qualified for the higher one, when they were transferred. But many of the associates thought it a hardship that they should be called by a name which did not imply full fellowship, and should be classed with persons "not necessarily civil engineers." Several schemes for dealing with this complaint were suggested, and ultimately, on the 2nd of December, 1878, the present constitution was adopted, namely, that the corporation should consist of members, of associates entitled to the privileges of corporate membership, and of honorary members. There was also the important class of associates attached to the Institution, but without corporate rights. These were persons not civil engineers by profession, but of eminence in some other walk of life, as scientific men, contractors, railway managers, military engineers and others. The class of students has been already referred to.

The Council.—In 1838 the composition of the governing body was altered. Previously it had consisted—including the President and four Vice-presidents—of twelve councillors, chosen entirely from the class of members; but it was then deemed advisable to add two selected from the associate class, and one additional from the member class, making the total number fifteen. In the session 1839-40 this number was increased to seventeen, two being from the associates as before. A formal requisition having been received, a special general meeting was held on the 3rd of May, 1855, to consider propositions for making certain changes in the constitution of the council, such as causing a certain number to retire every second year. After full discussion these propositions were withdrawn. In the session 1871 a numerous body of members proposed that the number of the council should be increased to twenty—the maximum permitted by the Charter—and that a broader basis of election should be adopted. Two special general meetings were held, at the first of which the increase was carried, and at the second it was resolved to alter the mode of preparing and printing the balloting lists. Two years afterwards it was suggested that absent members should have the power of voting for the council by voting papers; but it was found, apart from the merits or otherwise of the proposal, that this would be inconsistent with the provisions of the Charter. The suggestion was renewed in 1883, with the same result.

The Presidentship.—At the end of 1844 an alteration was made which had materially influenced the future of the Institution. This was a change in the duration of the presidentship. Mr. Walker had occupied the chair since the death of Telford, a term of ten years; and although the regulations required annual election, there was an implied understanding that the appointment should be a permanent one. It had, however, been represented that a shorter period for the tenure of the office of President, and of the other posts in the council, would be advantageous. As the result of several meetings, Sir John Rennie was elected President, and took his seat at the ordinary meeting on the 4th of February, 1845. Certain changes were then made in the bye-laws, to the effect that in future no member should be nominated by the council for election to the office of President for more than two years consecutively, and that at the expiration of such two years he should not be re-eligible for three years. In the report for 1880 the council alluded to the existence of a general feeling that it would be desirable for a President in future to hold office for one year only, and that the practice of nominating the same person for two years consecutively should be discontinued. In consequence, the then President, Mr. W. H. Barlow, F.R.S., intimated that he did not wish to be proposed for President a second time. Since that date there had been an understanding that the President should hold office for one year only, although there had been no change on the subject in the bye-laws.

The Secretaries.—During the year 1837 Mr. Thomas Webster. M.A., a well-known barrister, was appointed to the office of secretary. In the session 1839-40 it appeared to the council that the increasing business required the whole and undivided time and attention of a properly qualified gentleman to fill the position as a paid officer, and it was taken, on this condition, by Mr. Charles Manby, who entered upon the duties at midsummer, 1839. He held the post for seventeen years, and subsequently continued to act as honorary secretary till his death, on the 31st July, 1884. The present secretary had held office for thirty years. In January, 1885, Dr. William Pole, F.R S., was appointed honorary secretary in succession to Mr. Manby.

The Publications.—The "Proceedings" were first published in 1836, when a handsome quarto volume of "Transactions" was issued, containing a certain number of selected papers. This was followed in 1838 by a second similar volume, and in 1842 by a third volume. In the meantime, in 1837, the publication of the smaller "Minutes of Proceedings" in octavo was commenced. A fourth volume of quarto "Transactions" had been contemplated, but on account of the great cost the matter was referred to a committee for consideration. The report of that committee represented that the quarto form, with elaborate plates, was found, as it had been in other societies, to be too expensive; that the selection of certain papers, to the exclusion of others, might be considered invidious; and that the delay in the publication of the papers was prejudicial to the interests of the authors, and had prevented many valuable communications being presented. These arguments prevailed, and it was decided that, from the 12th of March, 1844, the papers should be printed in octavo in full, with the necessary illustrations. Thereafter, until the year 1870, the "Minutes of Proceedings" for each session were contained in one volume; but then it became necessary to issue two volumes annually owing to the increasing bulk of the "Proceedings." Three years later, it was thought desirable to introduce some material extensions. Hitherto, only such papers were printed which had been read and discussed; but these were necessarily limited in number, while many others were received of such importance as to demand publication. Accordingly it was decided to add a second section for communications not read at the meetings, to be called "Other Selected Papers," a departure that had been highly appreciated. At the same time a further addition was determined on, namely, the organisation of a scheme by which the volumes should contain a summary of information, gathered from the transactions of foreign engineering societies and from foreign scientific periodicals, on all branches of professional knowledge, so as to afford a record, however brief, from year to year, of the progress of engineering science. The "Minutes of Proceedings" were then enlarged to four volumes annually, brought out at as nearly equal intervals as possible, and they contained a full account of all matters of professional interest. Copies were sent, post free, to every member of every class wherever resident.

The House.—In March, 1820, rooms were hired at 15, Buckingham-street, Adelphi, and in 1834 a small house was taken at No. 1, Cannon-row, Westminster; but as the numbers increased the accommodation was found to be too limited. It was then attempted to obtain from the Government, as other scientific societies had done, apartments in Somerset House—an application that was fortunately unsuccessful—so that suitable premises had to be sought elsewhere. It happened, just at this time, that a house was found in perhaps the most appropriate situation that could have been selected, and at Christmas, 1839, the Institution entered into possession of the premises at No, 25, Great George-street. Here a meeting-room, about 30ft. square, was erected in the rear of the front house, and in it the meetings were continued for several years. In 1846 the necessity for a larger room became urgent, and then on the same area, by encroaching on the middle of the block, a meeting-room measuring 40ft. by 30ft. was built, and other alterations were effected at a cost of £4350. To meet this outlay it was arranged that every member should subscribe £7 7s., and every associate £4 4s., and that new members and associates should enter into an obligation to contribute like sums to form a "Building Fund" for defraying future expenses of the same kind. To provide, however, for the immediate requirements, debenture bonds of £100 each, to the extent of £2500 were issued, all of which were in some way or other subsequently surrendered and cancelled. Again, in 1865, it became apparent, owing to the great increase in the numbers and to the large attendance at the meetings, that further accommodation was needed. The subject then received the constant and serious consideration of the council, when a recommendation was made that Nos. 15 and 16, Great George-street, should be acquired, and that on that site an entirely new building should be erected. The cost of carrying this proposal into effect was estimated at about £60,000, which it was suggested should be defrayed partly by private subsscriptions, partly out of the funds of the Institution, and partly by raising money on mortgage. This proposal was subsequently negatived, and it was decided that the subscription list, which amounted to about £25,000, should be withdrawn. The matter was allowed to remain in abeyance for a short time, but in April, 1868, two projects were submitted to a special general meeting, at which one of them, for enlarging the building on the existing site with the addition of the back part of No. 24, Great George-street, was adopted, constituting the building essentially as it at present existed. The cost inclusive of furniture amounted to between £17,000 and £18,000, which was paid for entirely out of the accumulations of the building fund, of the unconditional bequests, and of Institution investments, leaving stocks of the nominal value of £3000 to meet future contingencies. After a lapse of eighteen years, the council stated that although the meeting-room, 60ft. long by 40ft. wide and 30ft. high, was fairly large enough, except on extraordinary occasions, this could not be said of the library nor of the offices, which were very insufficient and unsuitable for the increasing business.

The Roll.—In 1836 there were on the register 146 members, 100 associates—many of whom were afterwards transferred to the class of members—and 14 honorary members—together 254. The gross numbers at subsequent decennial periods were 600, 797, 1339, 2884, and on the 31st of March last 5100.

Finance.—During the period under review, it was stated that while the annual receipts from all sources amounted in 1836 only to £713, in the last session they had risen to £19,945. In the year 1860, the first investment was made on capital account, being the sums derived from life compositions—in lieu of annual subscriptions—and from fees on entrance, neither of which receipts could be regarded in the light of annual income. This practice had since been regularly continued, and had resulted in the Institution at present being possessed of stocks of the nominal, or par, value of £57,000, their market value being about £66,000. During the interval the life compositions and admission fees together realised £50,045, and the unconditional bequests £8088. The cost of the rebuilding of the premises in 1868 had therefore practically been paid for out of income, although the annual subscriptions of the members of all classes had not been increased since they were fixed on their present scale in December, 1837.

In the report, of which the above was a summary, the foregoing matters were referred to in consecutive and chronological order. It was next considered desirable to give a further account of the constitution, of the objects for which the Institution was established, and of the way in which those objects were sought to be carried out.

CONSTITUTION.

The persons for whose benefit the society had been formed were defined by its chartered title The Institution of Civil Engineers. As the exact meaning of the words "Civil Engineers" had given rise to much discussion, the council considered it desirable to state the sense attached to them by the Institution. The Charter defined "the profession of a civil engineer" as "the art of directing the great sources of power in nature for the use and convenience of man," and some examples of this definition were given. But it was pointed out by Thomas Tredgold, who drew up the "Description of a Civil Engineer," partly embodied in the Charter, that "the scope and utility of civil engineering will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical science." Consequently, since the Charter was drawn, the range of practice of the profession had become much enlarged. It was important to define accurately what was meant by the prefix "civil." There had sometimes been a disposition to confine the word "civil" to those who practised in works, such as railways, roads, harbours, docks, river-improvements, and so on, to the exclusion of engineers engaged in some of the other branches of engineering. There was no authority or warrant for such a limitation. The meaning of the word "civil" was quite clear when the history of the profession was borne in mind. The earliest application of the term "engineer" was to persons in military service, and down to a recent period it was only known in that application. But when the construction of public works in England for civil purposes began to take a large development, their designers, finding their work analogous to that of military engineers adopted the same term, using the prefix "civil" to distinguish them. There was reason to believe that Smeaton was the first civil constructor of large public works who called himself an engineer, and who used accordingly the distinguishing compound title. The term "civil engineer" meant, therefore, merely an engineer who was a civilian, as distinguished from a military engineer. The corporation was intended to include all classes of engineers—all those whose profession it was to direct and utilise the great sources of power in Nature—who did not belong to the military service; and the many and varied classes of works which practitioners in the art might be called upon to perform were enumerated.

The report then proceeded to deal succinctly with the organisation of the governing body, the sessions and meetings, the "Minutes of Proceedings," the house and library, the trust funds and premiums, and the annual dinner.

PROCEEDINGS OF THE SESSION 1885-86.

During the twelve months ending on the 31st of March, 1886, there had been an increase of 57 members, 179 associate members, and of 85 students, while the number of honorary members was the same, and there had been a decrease of 6 associates. The effective increase had thus been 315, bringing up the total of all classes to 5100. Twenty-five ordinary meetings had been held, when eighteen papers, treating of twelve different subjects, had been read and discussed. These related to the "Steam Engine Indicator," "High Speed Motors" and "Dynamo Electric Machines," "Construction in Earthquake Countries," "Gas-producers," "The Injurious Effect of a Blue Heat on Steel and Iron," "The River Seine," "The Explosion of Gaseous Mixtures in a Closed Vessel," "Railways in Newly Developed and in Mountainous Countries," "Water Purification," "Brickmaking by Machinery," "The Mersey Railway," "The Mersey Railway Lifts," and "Modern Machine Tools." For some of these communications the council had had the satisfaction to award medals and premiums as under:—A Telford Medal and a Telford Premium to Gisbert Kapp, Assoc. M. Inst. C.E.; a Telford Medal and a Telford Premium to Charles E lmund Stromeyer, Assoc. M. Inst. C.E.; a Watt Medal and a Telford Premium to John Imray, M.A., M. Inst. C.E.; a Telford Medal and a Telford Premium to Leveson Francis Vernon-Harcourt, M.A., M. Inst. C.E; a Telford Premium to Dugald Clerk; a George Stephenson Medal and a Telford Premium to Francis Fox—of Westminster—M. Inst. C.E.; a Watt Medal and a Telford Premium to William Wilson Hulse, M. Inst. C.E.; Telford Premiums to William Edmund Rich, M. Inst. C.E.; Henry Ward, Assoc. M. Inst. C.E. and Professor Osborne Reynolds, M.A., F.R.S, M. Inst. C.E.; and the Manby Premium to Arthur William Brightmore, B.Sc., Stud. Inst. C.E.

For papers printed in the second section of the proceedings without being publicly discussed, the following awards had been made:—A George Stephenson Medal and a Telford Premium to Stanislao Fadda; and Telford Premiums to James Strachan, M Inst. C.E.; Robert Hunter Rhind, M. Inst. C.E.; Thomas Andrews F.R.S.E., Assoc. M. Inst. C.E.; Bryan Donkin, jun., M. Inst. C.E.; and Frank Salter, B.Sc., Assoc. M. Inst. C.E.; and to John George Mair, M. Inst. C.E.

Thirteen papers were read at twelve supplemental meetings of students, the subjects having been fairly representative of the present advanced position of engineering. Miller Prizes had been awarded to the authors of several of these papers, namely, to John Goodman, Wh. Sc., Henry Albert Cutler, Leslie Stephen Robinson, and Edward Carstensen de Segundo, William Andrew Legg, Gilbert Macintyre Hunter, Llewelyn Birchall Atkinson, Rudolph Emil von Lengerke, David Sing Capper, M.A., Maurice FitzMaurice and Ernest William Moir.

The accounts showed that the receipts from all sources had amounted to £19,945 15s. 9d., against payments—including an investment on capital account—aggregating £19,113 17s. 1d. The gross receipts and payments were presented under three heads on each side of the financial statement, and were as under:—

Receipts.	£	s.	d.	Payments.	£	s.	d.	Excess of Receipts over Payments.	£	s.	d.
Income ..	15 691	8	6	.. General ..	15,487	0	1	..	204	8	5
Capital ..	3,813	12	0	.. Investment	3,281	5	0	..	532	7	0
Trust Funds	440	15	3	.. Trust Funds	345	12	0	..	95	3	3
Totals ..	£19,945	15	9	..	£19,113	17	1	..	£831	18	8

Of the income, £2041 5s. 2d. arose from dividends on capital investments, while as regarded the general expenditure, three-fifths nearly—or £9178 4s. 11d. actually—would be found debited to publications.

In conclusion, the council felt that it need not do more than refer to the historical and descriptive notice which it had thought right to offer in order to show the high character and position which the Institution had attained.

The adoption of the report, having been duly moved and seconded, it was declared to be carried, and ordered to be printed in the "Minutes of Proceedings" in the usual manner. Hearty votes of thanks were then passed to the President, to the Vice-presidents and other members of the council, to the auditors, to the secretaries, and to the scrutineers.

The ballot for council resulted in the election of Mr. E. Woods, as President; of Mr. G. B. Bruce, Sir John Coode, Mr. G. Berkley, and Mr. H. Hayter, as Vice-Presidents; and of Mr. W. Anderson, Mr. B. Baker, Mr. J. W. Barry, Sir Henry Bessemer, F.R.S., Mr. E. A. Cowper, Sir James N. Douglass, Sir Douglas Fox, Mr. A. Giles, M P., Mr. J. Mansergh, Mr. W. H. Preece, F.R.S., Sir Robert Rawlinson, C.B., Sir E. J. Reed, K.C.B., F.R.S., M.P., Mr. F. C. Stileman, Sir William Thomson, F.R.S., and Sir Joseph Whitworth, Bart., F.R.S., as other members of council.

The session was then adjourned until the second Tuesday in November, at 8 p.m.

THE MANCHESTER GEOLOGICAL SOCIETY.—A new safety lamp, which is a combination of the Jack lamp and an improved Muesler, was exhibited by Mr. M. Mercier at the meeting of the Manchester Geological Society on Tuesday. This lamp consists of an upper and lower gauze connected together by two stamped brass rings with flanges. Inside there is placed a chimney with a small vertical gauze in lieu of the horizontal gauze in the Muesler chimney, which rests on the seating formed by the lower gauze ring, and is held closely in position by the flange of the upper ring. The gauzes are surrounded by two shields, and a glass, fixed for the use of colliers, which slides up between the shields. The outer shield is a fixture, and its purpose is to protect the inlet holes of the inner shield when in high velocities, and also to be a cool medium by which to hold the lamp. The inner shield is moveable, and has a row of holes for the admission of air above the glass, these holes being again protected by an inner ring or shield. The outlet holes at the top of the lamp are only large enough to allow the escape of the products of combustion of the wick flame, and are protected also by a ring or shield. The glass fits closely against the flanges of the brass rings, and makes a good joint at the top. At the bottom the glass rests in a groove formed by the screw ring having a rim projecting upwards into the glass, and as it only screws a portion of the depth of the lamp collar, it is protected on the outside by a rim of metal, and so makes a tight joint. To protect the edges of the glass from getting chipped there is a tight-fitting brass ring on the glass. The gauzes are fastened to the rings, and so prevent the danger of their stretching and making a loose or imperfect joint. There is also a smoke cap on the chimney to protect the gauze from getting burnt at the crown, where there is a double thickness of gauze, and all the fine loose parts of the lamp are put together before screwing into the lamp framing. Mr. Mercier also exhibited in connection with his lamp an extinguishing lock, which can be applied to any form of lamp. This lock has what is termed an extinguishing lever, which in unlocking brings a cap over the flame, and the light is put out. At the same meeting a discussion took place with reference to the electric lighting of mines, during the course of which it was mentioned that gas had actually been exploded in a mine by means of an electric spark from the wires connected with the electric lamps by which it was being illuminated. It was also very much questioned whether the breaking of an incandescent lamp in the midst of an explosive atmosphere would not endanger the ignition of the gas, and it was urged that experiments might easily be made to test whether this would be the case or not.

RAILWAY MATTERS.

THE Dominion House of Commons has passed a resolution in favour of constructing a railway through Cape Breton Island, which would make the shortest route to England.

MESSRS. P. AND W. M'LELLAN, of Glasgow, have obtained the contract to supply the steel work of ten bridges, four of which are to be 100ft. span, and six 75ft., for the Midland Railway of India.

A SIGNALMAN on the Somerset and Dorset Railway at Binnegar has been found guilty of the manslaughter, through not showing the proper signal, of a stoker in the employ of the same company, and sentenced to six months' imprisonment with hard labour.

TWO young men were charged, and one sentenced to six months' imprisonment, at the Leeds Assizes on Saturday, for moving the handle of an air valve connected with a Westinghouse brake attached to a train on the North-Eastern Railway between Redcar and Middlesbrough, on March 26th, by which the train was obstructed on its journey.

WHAT is regarded as an engineering feat was accomplished a few days ago on the Great Western Railway, between Worcester and Hereford. The communication between these two cities was destroyed by the washing away of a large brick bridge over the river Tame, but within four days a temporary wooden structure of 65ft. span had been erected, from the designs and under the superintendence of Mr. Armstrong, C.E., of Hereford.

IRONMASTERS doing an export trade *vid* the port of Hull expect to derive benefit from the competition which has been established by the Hull and Barnsley Railway and Dock Company with the North-Eastern Railway Company to and from Hull. The Hull and Barnsley Company has recently opened agencies in the Wolverhampton district, and their enterprise cannot fail to be advantageous to local traders. The new railway serves Staffordshire in connection with the Midland, the London and North-Western, and Great Western Railways.

AN American paper says, "There is an excellent prospect that there will be a large increase in the railway mileage of Colorado during this year. The Colorado Midland R. R. has already let the contract for the construction of a standard gauge road from Leadville across the range to the mouth of Frying Pan. It is rumoured that the Denver and Rio Grande R. R. will be taken out of the hands of the Receiver, and that upon the reorganisation of the company the extension of its Red Cliff line will be begun. It is not unlikely that the Burlington will begin work upon a line to be run from Denver through Middle Park toward the western border of the State. Work will be begun within a month upon the extension of the Denver and New Orleans, or as it is now called, the Denver, Texas, and Gulf R. R., and it is expected that at the Canadian river a connection will be made with the Fort Worth and Denver R. R. The length of the road to be built is a little less than 300 miles, but the projectors think they can build this before the close of the year. Much of the route presents no obstacles worth mentioning to the construction of the road, and the track can therefore be laid very rapidly."

ON Saturday, May 29th, Major-General Hutchinson, of the Board of Trade, made an official inspection of the new branch line of the Caledonian Railway, from Whifflet to Airdrie—constructed by Messrs. Braddock and Matthews, of Southport—testing the various viaducts, &c., previous to the opening of the route for passenger traffic. Although the branch line is little over three miles in length, it has taken three years to construct, having proved a much more arduous undertaking than was expected. The line crosses the Monkland Canal, over which it is carried by a viaduct about 360ft. long, and which has been, perhaps, the most difficult portion of the work of constructing the line. Besides some very deep cuttings, there are twelve bridges, nearly all of large dimensions, the most important being those carrying the line over the Caledonian and North British lines at Whifflet, across the Monkland Canal at Rochsolloch, and over the North British Railway at Airdrie. The masonry generally consisted of cement, rubble concrete, faced with freestone facings built in cement. The amount of cement used in the whole work is given at 4500 tons. The difficulties experienced with the earthworks and cuttings were exceptionally heavy, and entailed the removal of fully 500,000 cube yards of earth, sandstone, and blaize. Enormous masses of rock were met with in the cuttings, through which the progress was, as a matter of course, very slow. We understand that the inspecting officer found no fault with anything in the course of his inspection, the work being of a most satisfactory character.

IN reporting on the collision which occurred on March 2nd at Linlithgow, on the North British Railway, where a passenger train from Edinburgh to Glasgow, approaching Linlithgow station, came into collision, engine to engine, with the 6.5 p.m. up goods train from Bo'ness to Portobello, which had been shunted from the up to the down line to clear the way for the up mail-bag train, and was in the act of drawing forward into a siding on the down side of the down line, Major Marindin makes some remarks on back lights. It appears that five passengers and the fireman of this train were injured, and the guard of the goods train was run over and killed by the engine of the mail-bag train. The passenger train was running slowly, and the goods train was only just moving, so that the damage to the rolling stock was slight, a return being given in an appendix. Major Marindin says:—"One lesson to be learnt from this collision is that there is a certain element of danger in the extensive use of back lights showing in certain positions similar colours to those used for signal lights, and I am strongly of opinion that it would be better to use a distinct colour for back lights. I believe that it will be found that the best system, taking all things into consideration, would be to keep the red light, as at present, for the danger signal, but to use the green light—as is now done on some lines everywhere, and on most lines at junctions—as an 'all right' signal, a white light, such as would be shown if a glass were broken, indicating a signal out of order, and therefore one to be treated as a danger signal. For back lights, which are only required to show that the lamp is burning, a small white or purple light might be used, and as on nearly all lines the normal position of the signals is at danger, the back light need only show when the signal-arm is in that position."

M. HENRY MATHIEU, chief engineer of the Southern Railway of France, has found that the average yearly consumption of sleepers on 80 per cent. of all the French railways for the five years ending with 1882 had been 92 per kilometre, equal to 148 per mile of line excluding yards and sidings. Returning to the subject recently, he finds in 1883 the average consumption rose to 170 per mile, and in 1884 144½ per mile, and the average for the two years 159 per mile. The *Railroad Gazette* says:—"French railways are reported to have 1450 sleepers per kilometre, or 2332 per mile, which puts them 27in. only from centre to centre, and the consumption for maintenance indicates an average life of from 13⅜ to 16½ years for the sleepers. Most of the railways report the number of sleepers used of each kind of wood, from which it appears that in 1883, 69·7 per cent. of them all were of oak, 15·6 beech, 12·1 pine and fir, and 2·6 chestnut and other woods, but in 1884 the proportions were quite different—60 per cent. oak, 22·1 beech, 15 6 pine and fir, and 2 3 chestnut, &c. Of the total number of sleepers reported used, 24 per cent. were imported in 1883, and 20⅔ per cent. in 1884. M. Mathieu says that the life of sleepers is increased one-half on the average by preservative processes; that of all the antiseptics tried in France only creosote and sulphate of copper are still used, and that creosote is generally preferred. An oak sleeper costing 5½f. is preserved at a cost of about a franc. On the Southern Railway, where three-fourths of the sleepers used are of the pine that grows on the Landes, these sleepers cost from 36c. to 38c. each, and are preserved with copperas for 14c. and with creosote for 19c. each. The Orleans Railroad uses the same kind of sleepers, preserved with creosote, for about one-sixth of the whole consumption. The Northern Railroad finds that the use of a tarred felt paper between the rail and sleeper increased the life of the latter about two years."

NOTES AND MEMORANDA.

ATTEMPTS are being made at the Mint to revive the art of casting medals, practised with so much success in Italy in the 15th century.

IN Greater London, last week, 3190 births and 1508 deaths were registered, corresponding to annual rates of 31·4 and 14·8 per 1000 of the population.

THE deaths registered last week in 28 great towns of England and Wales corresponded to an annual rate of 17·7 per 1000 of their aggregate population, which is estimated at 9,093,817 persons.

IN London 2431 births and 1229 deaths were registered last week. The annual death-rate per 1000 from all causes, which had declined in the ten preceding weeks from 30·3 to 17·3, further fell last week to 15·5, a lower rate than has been recorded in any week since September last.

MR. A. P. LAURIE recently read a paper before the Royal Society of Edinburgh on the measurements of the E.M.F. of a constant voltaic cell with moving plates. Mr. Laurie determined the E.M.F. of a cadmium-iodine cell by drawing a large current from it, while the plates were kept moving. The value so got agreed with that given on open circuit as determined by the electrometer, thus showing that the fall of the current when the plates were not moving was due to alteration of the composition of the layers of liquid next the plate.

AT a recent meeting of the Edinburgh Royal Society, Sir W. Thomson exhibited and described a new form of portable spring balance for the measurement of terrestrial gravity. In this instrument a metallic spring is used. The curvature of the spring when unweighted is such that when one end is firmly clamped and a suitable weight attached to the other end, the spring becomes straight. When so arranged, the equilibrium of the spring and weight can be made as nearly unstable as is wished by simply tilting the instrument. Hence the apparatus can be made as delicate as necessary.

LONDON is at present supplied with water from the rivers Thames and Lea, and from certain springs in the valleys of the Thames ane Lea, supplemented from Chadwell springs, and from eleven wells in the north of London, and ten wells in the south of London, all down to the chalk. The proportions for the month of April, 1886, are nearly as follows:—From the river Thames and certain chalk springs in the Thames Valley, about 51 parts of the whole; from the river Lea and certain chalk springs in the Lea Valley, about 37 parts; from the eleven chalk wells on the north of London, about 4 parts; from the ten chalk wells on the south of London, about 8 parts.

THE death is announced of Dr. E. Linnemann, Professor of Chemistry at Prague, which occurred on April 27th. Among his papers a letter was found addressed to the Vienna Academy of Sciences containing a oommunication on a new chemical metallic element called austrium—Aus. This new element, *Nature* says, was prepared by the late Professor Linnemann from orthite of arendal. The spectrum of austrium shows two violet lines; the wave-lengths were found to be, for Aus α, $\lambda = 416{\cdot}5$, and for Aus β, $\lambda = 403{\cdot}0$. According to a note made by Professor F. Lippich, of Prague, who communicated Professor Linnemann's letter last week to the Vienna Academy, three not yet identified lines—$\lambda = 415{\cdot}56$, $\lambda = 416{\cdot}08$, and $\lambda = 416{\cdot}47$—are shown in Angström's atlas of the normal spectrum of the sun in the neighbourhood of the Aus α line; the last of them might be supposed coincident with the Aus α line—$\lambda = 416{\cdot}5$.

IN the New South Wales Court at the Indian and Colonial Exhibition is shown specimens of colonial auriferous antimony ore, as shipped in bulk to England, containing 61¼ per cent. metallic antimony and 3 oz. 12 dwts. of gold per ton; also 2 oz. 6 dwts. of silver per ton. Also of auriferous quartz and calcite, containing from 3 oz. to 6½ oz. of gold per ton, with small percentage of antimony. It is in consequence of the presence of antimony in this quartz that, although exceedingly rich in gold, it cannot be treated in the ordinary way by quicksilver amalgamation, and has to be shipped for treatment and extraction to the Royal Smelting Works at Freiberg, in Saxony, entailing a very large outlay for freight and expenses, which could be saved if the quartz could be treated on the mine. There are six shafts of more or less depth on the mine, the deepest of 115ft. The lode and reef is well defined, and varies in width from 1ft. 6in. to 3ft. The quantity of auriferous quartz that can be raised per week is from 80 to 100 tons. The quantity of antimony ore containing fine gold which has been shipped since the beginning of the working of this mine is 130 tons. The mine is between Capertree and Ilford, about 146 miles distance from Sydney.

IN speaking of the application of high temperature gas flames to heating rooms, Mr. F. Siemens says that a source of radiant heat of low intensity but of large surface, sending out its rays at various angles, heats an object in its vicinity very much more than is the case with a smaller source of radiant heat of greater intensity, whose rays strike the object from one direction only, notwithstanding that both sources radiate the same quantity of heat. This action was illustrated by reference to two rooms, the one heated by a small flame of high intensity, and the other by a large flame of low intensity, both radiating the same quantity of heat. Each room contained two objects—globes or spheres—the one close to, and the other at a distance from the source of heat. The object in the one room near to the source having the large heating surface is almost enveloped in rays, while that in the second receives rays only in one direction, the former therefore being much more heated than the latter. This difference does not occur when the two globes at a distance from the two sources of heat are compared. The law that the rays of heat are diminished in the inverse ratio of the square of the distance is only correct as regards small but intense sources of heat, whilst the decrease of radiant heat takes place in a much higher proportion, in the case of large sources of heat of low intensity. This clearly proves that for the purpose of warming rooms by means of radiation, it is important that the heat should be concentrated in an intensely hot focus, as is the case in nature, our earth being warmed in this way by the radiant action of the sun.

BUNSEN observed the dissociation of steam and carbonic acid by employing small tubes filled with an explosive mixture of these gases, to which suitable pressure gauges were attached. On igniting the gaseous mixture explosion took place, and a high momentary pressure was produced within the tube; from the pressure developed Bunsen calculated the temperature at which the explosion took place, and found that it varied with the mixtures employed. He records the circumstance that only about one-third of the combustible gases took part in the explosion, from which circumstance he concluded that the temperature attained was the limit at which combustion occurred. To prove this, Bunsen allowed the gases sufficient time to cool, after which a second explosion was produced, and even a third explosion when time was allowed for the gases to cool down again. Bunsen's theory seems very plausible, besides which he obains much higher temperatures for his limits of dissociation than other physicists, so that the figures at which he arrives might be accepted; these are for steam about 2400 deg. C., and for carbonic acid about 3000 deg. C. These temperatures are probably higher than are reached in the arts, as materials used in furnace building would not withstand such temperatures for any length of time; but Mr. F. Siemens calls attention to the circumstance that if the influence of the inner surfaces of the tubes on the combustion of the gases therein could be removed, the dissociation temperatures arrived at would be found still higher. He thinks that Bunsen's explanation of the cause of the second and third explosions is not quite satisfactory, as it is not the cooling of the gases alone which renders the subsequent explosions possible, but also the thorough re-mixture of the gases by diffusion after each explosion.

MISCELLANEA.

PALMER'S Shipbuilding and Iron Company, Jarrow, has appointed Messrs. G. Bailey Toms and Co., of Laurence Pountney-hill, E.C., its sole London agents for steel.

MESSRS. LANCASTER AND TONGE, of Pendleton, Salford, have supplied their "Lancaster" traps for draining all the steam pipes in the Liverpool and Edinburgh Exhibitions.

THE Beetaloo Waterworks, South Australia, consisting of a wall 560ft. long and 105ft. wide to dam up 700,000,000 gallons of water, will cost, it is believed, about £200,000, or £50,000 less than the original estimate.

MESSRS. LANCASTER AND TONGE have for yea s used "Lancaster" Pendleton as telegraphic address, but the Postmaster refuses to register this, and they have had to adopt the word "Pistons" instead.

THE Association of Municipal and Sanitary Engineers and Surveyors holds its Eastern Countries district meeting at Great Yarmouth to-morrow, Saturday, the 5th of June, 1886. Members will assemble at 1 p.m. in the Town Hall.

A GOVERNMENT Bill has been introduced by Mr. Duff, M.P., to empower the Admiralty to form a harbour of refuge at Peterhead in Aberdeenshire, and to execute and maintain breakwater, piers, and a short line of railway, and other works in connection therewith. As "convict labour may be usefully employed in the execution of these works," provision is made for the building of a prison on the spot.

THE President of the United States in a message to the House has suggested that the 3rd of September be set apart as an appropriate day for the inauguration of the Bartholdi Statue of Liberty. This day is selected as being the anniversary of the signing of the treaty of peace at Paris, by which the independence of the United States was recognised and secured. He asks that a sufficient amount be appropriated by Congress for the suitable recognition of this event.

THE first of the two 110-ton guns which are being made at Sir William Armstrong's works as the armament of the Benbow, is now ready for shipment to Woolwich, for proof at the Arsenal butts; and though the precise date for moving the enormous weapon round to the Thames has not yet been fixed, it is expected that the operation will be commenced in a few days. A special carriage for the weapon has been made at the Royal Carriage Factory at Woolwich.

IN connection with the coinage of threepenny pieces, the deputy-master of the Mint observes that the Australian colonies are apparently beginning to appreciate the convenience of these small coins, for, while in 1884 an amount of £3200 was sufficient to meet the demand from New South Wales and Victoria, the demands from these colonies had increased in 1885 to £7600 and £4400 respectively; and since the beginning of the current year threepences of the nominal value of £11,000 have been shipped to Sydney, and £4800 to Melbourne. The Government of Queensland also obtained £3200 in threepences during 1885, and in the present year £3000 have been shipped to South Australia.

AN attempt was made on Monday last to sell by auction several screw steamers belonging to the port of Whitby. Although there was a large attendance and considerable interest in the proceedings, no sales were actually effected. One steamer was, however, sold by private contract afterwards. The extreme difficulty of selling shipping property at present may perhaps be gathered from the ratio of the highest bid to the reserve prices. Thus in one case the former was £560 and the latter £2111 17s. 6d. In another case £500 was the nearest approach to a reserve of £3455 6s. 3d. In another £620 and £2450 18s. 9d. were the figures. The size of the steamers varied from 850 to 1250 tons dead weight.

A FEW days ago Messrs. Fuller, Horsey, Sons, and Cassells opened the tenders which for some time past have been invited for the purchase "as a going concern" of the River Thames Steamboat Company. The property of the company comprises a fleet of fifty-seven paddle steamers, nineteen of which are at present laid up and without certificates, steam launches and coal barges, wharves at Woolwich and Battersea, and numerous piers and approaches on both sides of the river. The average receipts from passenger fares during the past four years amounted to £83,696, but last year they fell to £71,000, and the year's working resulted in a loss of £11,000. None of the tenders approached the reserve prices fixed by the vendors, and the property remains unsold.

MESSRS. OLDHAM AND RICHARDS, of Manchester, have just patented a new pulley for driving planing machines, which requires no strap-fork, and takes the place of the three pulleys usually required for driving, reversing, and loose running. This is effected by carrying within the pulley a couple of friction cones actuated by a lever from the machine. The pulley itself constantly runs loose, and as the machine has either to be driven or reversed, one or other of the friction cones is brought into action. By this arrangement the driving-strap constantly remains on the one pulley, and a considerable saving of wear and tear is effected, whilst there is no loss of time in stopping the machine for changing the strap from one pulley to another, and the driving gear is brought within smaller compass.

ON Saturday last the quarterly meeting of the Manchester District Institution of Gas Engineers was held at Barnsley. About sixty members attended from different towns in Yorkshire, Lancashire, Derbyshire, and Cheshire. After inspecting certain additions to the new gasworks—including a new telescope gasholder, tanks, &c.—the party proceeded to the new chemical works, Bridwell, belonging to Messrs. Newton, Chambers, and Co., of Thorncliffe, which they had the privilege of inspecting. At Wentworth Castle, Stainbrough, the residence of Mr. T. F. V. Wentworth, special attention was paid to newly-erected machinery and apparatus by which the mansion is lighted by over 600 incandescent electric lamps. The members dined in the evening at the Queen's Hotel, Barnsley, under the presidency of Mr. C. E. Jones, C.E., Chesterfield.

AT the Royal Institution, on the 27th ult., Professor Dewar exhibited the method he employs for the production of solid oxygen. Last year he gave a lecture on liquid air, but although he and other experimenters had made liquid oxygen in small quantity, yet no one had succeeded in getting oxygen into the solid condition. The successful device employed at the Royal Institution depends upon allowing liquid oxygen to expand into a partial vacuum, when the enormous absorption of heat which accompanies the expansion results in the production of the solid substance. Oxygen in this condition resembles snow in appearance, and has a temperature about 200 deg. Centigrade—360 Fah. below the freezing point of water. It is suggested that a supply of this material will enable chemists to approach the absolute zero of temperature—461 Fah. and to investigate many interesting changes in the physical properties of bodies under the primordial condition of the temperature of space.

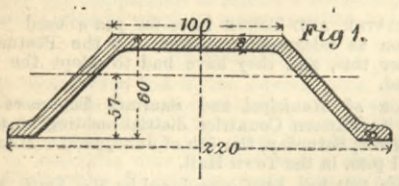
AT a meeting of the South Staffordshire Mines Drainage Commissioners in Wolverhampton on Wednesday, Mr. E. B. Marten, C.E., chief surface engineer, reported that the storm from the 10th to the 14th May was the heaviest recorded since the Commission was formed. So much rain in so short a time caused the streams to rise rapidly, and the trouble was increased by the opening of canal paddles and mill gates to save embankments. One embankment had given way, and much water had escaped, but it was quickly mended. On the whole, however, the damage from so unusual a storm was small, and the surface works prevented what would otherwise have been a most disastrous flood, both to mining and other property. The chief underground engineer reported that the heavy rains had caused the underground water to rise throughout the Bilston portion of the district, and at the Bradley engine the average quantity pumped in the week was 2,850,000 gallons every twenty-four hours.

METALLIC SLEEPERS, GERMAN RAILWAYS.

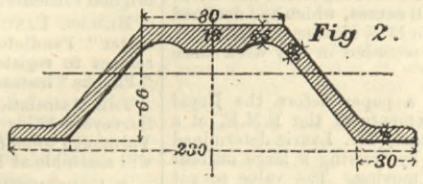
(For description see page 341.)

Cross Sleeper Profiles.

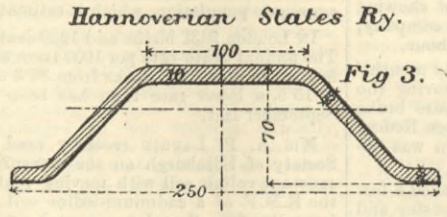
Main-Necker & Rhine Ry. Fig 1.



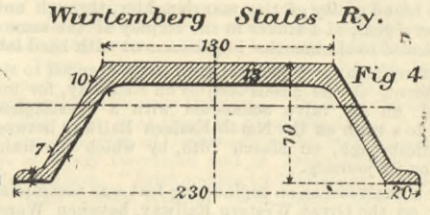
Berg Mark Ry old System. Fig 2.



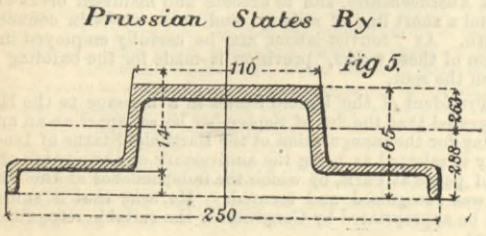
Hannoverian States Ry. Fig 3.



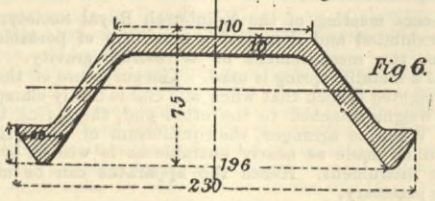
Wurtemberg States Ry. Fig 4



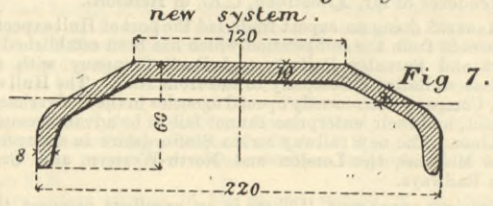
Prussian States Ry. Fig 5.



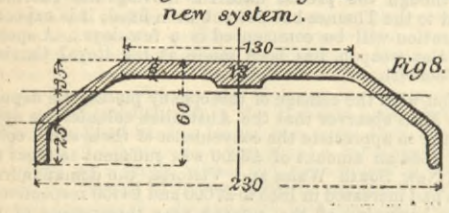
Alsace-Lorraine Ry. Fig 6.



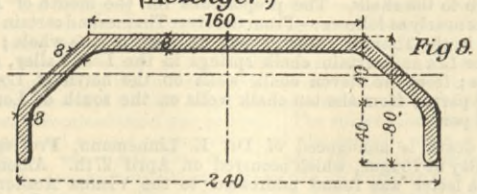
Hessian Ludwig Ry new system. Fig 7.



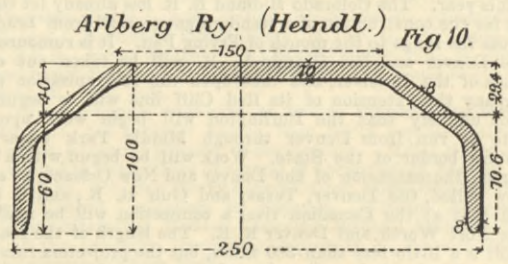
Berg. Mark Ry on new system. Fig 8.



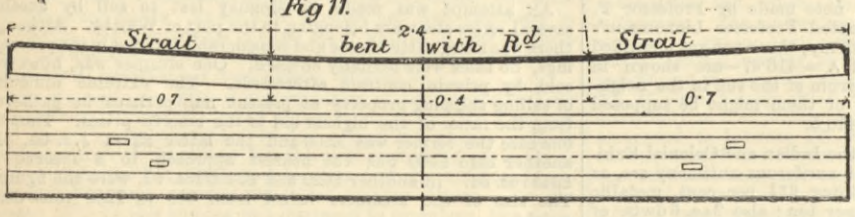
Austrian Franz-Josefs. (Alzinger.) Fig 9.



Arlberg Ry. (Heindl.) Fig 10.

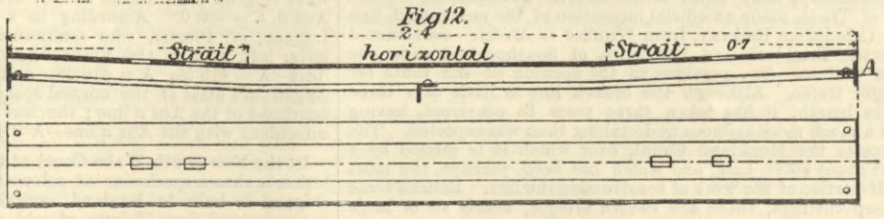


Alsace Lorrain Rys. Fig 11.

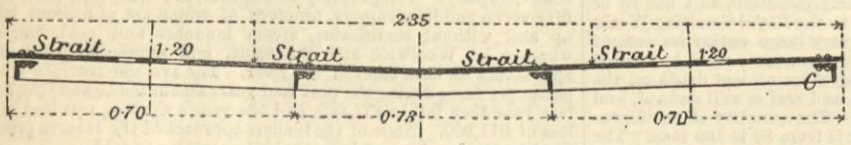


Longitudinal Section of Sleepers

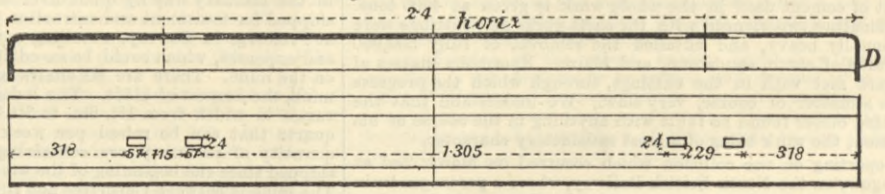
Prussian States Ry. Fig 12.



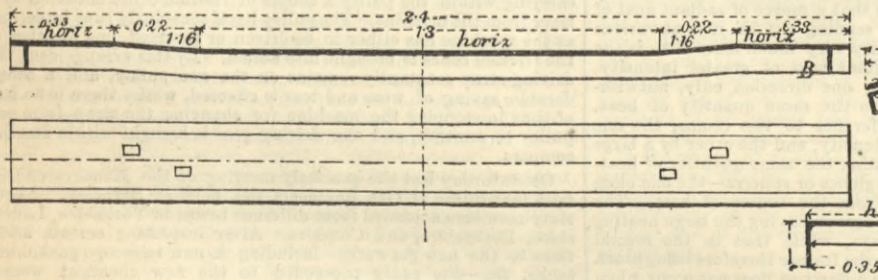
Halberstadt-Blankenburg. Fig 13.



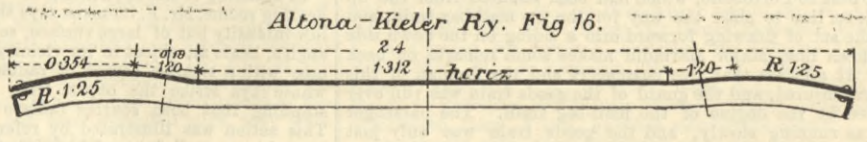
Arlberg Ry (Heindl.) Fig 14.



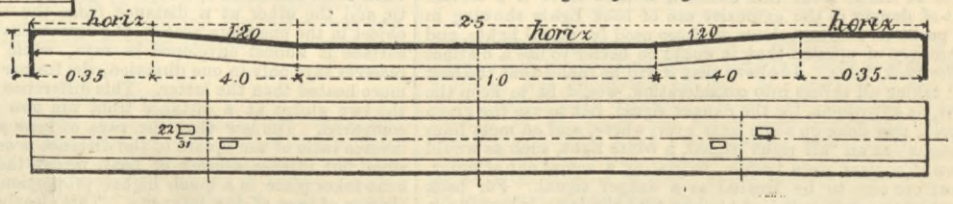
Franz-Josefs Ry. Fig 15.



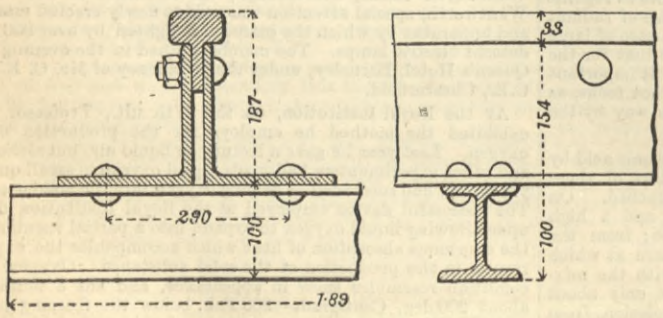
Altona-Kieler Ry. Fig 16.



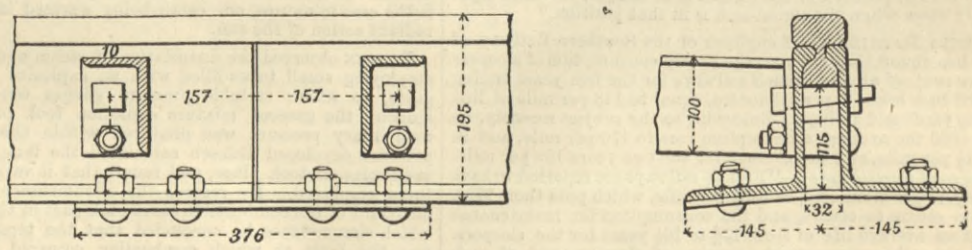
Hessian Ludwig Ry. Fig 17.



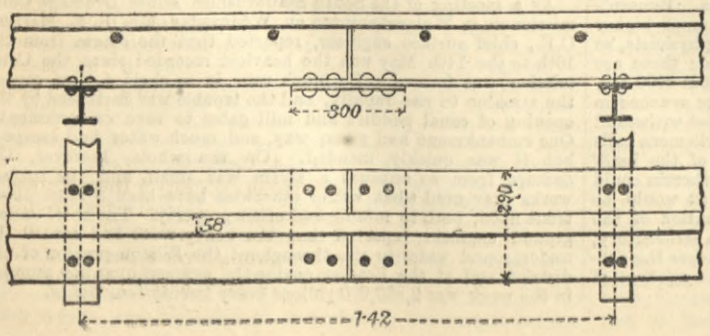
Construction A.



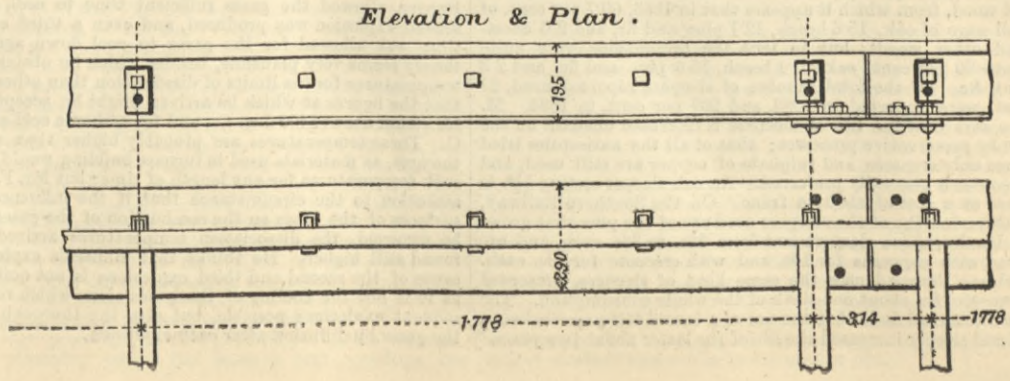
Construction D.



Elevation & Plan.



Elevation & Plan.



FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

PARIS.—Madame BOYVEAU, *Rue de la Banque.*
BERLIN.—ASHER and Co., 5, *Unter den Linden.*
VIENNA.—Messrs. GEROLD and Co., *Booksellers.*
LEIPSIC.—A. TWIETMEYER, *Bookseller.*
NEW YORK.—THE WILLMER and ROGERS NEWS COMPANY, 31, *Beekman-street.*

CONTENTS.

THE ENGINEER, June 4th, 1886. PAGE

TO CORRESPONDENTS.

Registered Telegraphic Address—"ENGINEER NEWSPAPER, LONDON."

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

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

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

TRINIDAD.—*J. Calvert, Great Jackson-street, Manchester.*

T. F. (Shaftesbury-place).—*You can obtain full information on the testing of lubricants from Mr. Bailey, Albion Works, Salford.*

H. H (Longsight).—*Your sketch shows a very imperfect form of feathering paddle-wheel. In the present day properly made feathering wheels are fitted to all paddle steamers.*

J. R. E. (Rail Joints).—*We do not think that English engineers are sufficiently interested in American systems of permanent way to render the publication of your letter necessary. We have nothing to learn in this respect from United States practice.*

PASSOVER CAKE MACHINERY.

(To the Editor of The Engineer.)

SIR,—Will any reader kindly tell me where I can obtain machinery for making Passover cakes? EASTER.
May 31st.

SUBSCRIPTIONS.

THE ENGINEER *can be had, by order, from any newsagent in town or country at the various railway stations; or it can, if preferred, be supplied direct from the office on the following terms (paid in advance):—*
Half-yearly (including double numbers).. .. .. £0 14s. 6d.
Yearly (including two double numbers).. .. .. £1 9s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made. THE ENGINEER *is registered for transmission abroad.*

Cloth cases for binding THE ENGINEER *Volume, price 2s. 6d. each.*

A complete set of THE ENGINEER *can be had on application.*

Foreign Subscriptions for Thin Paper Copies will, until further notice, be received at the rates given below:—Foreign Subscribers paying in advance at the published rates will receive THE ENGINEER *weekly and post-free. Subscriptions sent by Post-office order must be accompanied by letter of advice to the Publisher. Thick Paper Copies may be had, if preferred, at increased rates.*

Remittance by Post-office order. — Australia, Belgium, Brazil, British Columbia, British Guiana, Canada, Cape of Good Hope, Denmark, Hawaiian Islands. Egypt, France. Germany, Gibraltar, Italy, Malta, Natal, Netherlands, Mauritius, New Brunswick, Newfoundland, New South Wales, New Zealand, Portugal, Roumania, Switzerland, Tasmania, Turkey, United States, West Coast of Africa, West Indies, Cyprus, £1 16s. China, Japan, India, £2 0s. 6d.

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

ADVERTISEMENTS.

*** *The charge for Advertisements of four lines and under is three shillings, for every two lines afterwards one shilling and sixpence; odd lines are charged one shilling. The line averages seven words. When an advertisement measures an inch or more the charge is ten shillings per inch. All single advertisements from the country must be accompanied by a Post-office order in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.*

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

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

MEETINGS NEXT WEEK.

SOCIETY OF ENGINEERS.—On Monday, June 7th, at the Town Hall, Caxton-street, Westminster, at 7.30 p.m., a paper will be read "On Some Modern Improvements in the Manufacture of Coal Gas," by Mr. R. P. Spice, of which the following is a synopsis:—Historical *résumé*—introduction of clay retorts—the exhauster—charging and drawing machinery—dips and anti-dips—choked ascension pipes—difficulties occasioned by naphthaline—purification in closed vessels.

SOCIETY OF CHEMICAL INDUSTRY.—On Tuesday, June 8th, at the Chemical Society's Rooms, Burlington House, at 8 p.m., the following paper will be read:—"On the Chemical Treatment of Sewage," by Dr. Meymott Tidy.

GEOLOGISTS' ASSOCIATION, University College, Gower-street, W.C.—Friday, June 4th, at 8 p.m.: "On the Connection in Time of Changes in Fossil Floras with those of Faunas," by Professor G. S. Boulger, F.L.S., F.G.S. "A List of the Genera and Species of the Entomostraca found in the Carboniferous Formations of Great Britain and Ireland, with Notes on the Characters and Distribution of the Genera," by Professor T. Rupert Jones, F.R.S., and Mr. J. W. Kirkby. "On the Shingle Beaches and Recent Coast Changes of Romney Marsh"—in illustration of the Whitsuntide excursion—by Mr. W. Topley, F.G.S., president.

COLONIAL AND INDIAN EXHIBITION CONFERENCES.—Friday, June 4th, at 3 p.m.: Conference of the Royal Colonial Institute. Paper by Mr. J. D. Wood, "The System of Land Transfer adopted by the Colonies." Saturday, June 5th, at 3 p.m.: Conference of the Geologists' Association. Paper by Professor Valentine Ball, F.R.S., "The Mineral Resources of India." Monday, June 7th, at 4 p.m.: Conference of the Anthropological Institute. "Native Races in British Possessions in America and the West Indies." Tuesday, June 8th, at 2 p.m.: Conference of the National Association for Promoting State-directed Colonisation. At 8.30 p.m.: Lecture by Mr. Alexander Begg, "The Canadian North-West." Wednesday, June 9th, at 4 p.m.: Paper by Mr. L. J. Shand, "British-grown Teas." Thursday, June 10th, at 4 p.m.: Paper by Mr. Vincent Robinson, "Indian Carpets." At 8.30 p.m.: Lecture by Mr. F. W. Pennefather, "The Industries of New Zealand." Friday, June 11th, at 3 p.m.: Conference of the Royal Colonial Institute. Paper by Mr. F. Young, "Emigration to the Colonies."

THE ENGINEER.

JUNE 4, 1886.

THE VYRNWY DAM.

OUR readers are no doubt aware that Mr. Hawksley has expressed an opinion that the Vyrnwy dam is not quite what it ought to be. We have dealt pretty fully with various questions which have been raised from time to time concerning this structure, and a description of it, with sections, will be found in our impression for Feb. 5th, 1886. It is unnecessary now to repeat what has already been stated concerning the relative positions and responsibilities of Mr. Hawksley and Mr. Deacon. The City Council, whatever their own opinions might be, could not afford to ignore those of so eminent an authority as Mr. Hawksley, and they accordingly instructed the Water Committee to employ two engineers, skilled in the construction of masonry dams, to examine the Vyrnwy embankment and report on it. In Great Britain there are very few dams of the kind, and none of any considerable dimensions; but on the continent of Europe and in India they are tolerably abundant. It was, therefore, not easy to find two English engineers competent to give a weighty opinion. Major-Gen. Sir Andrew Clarke and Mr. Russel Aitken, M.I.C.E, were selected. The former has had a large experience in India, and the latter in this country—having played an important part in the construction of Dover breakwater. These gentlemen have made an exhaustive inquiry, and have sent in two separate reports. The Liverpool Corporation and Mr. Deacon may be content. Both reports are eminently favourable, and no doubt of any kind need be entertained as to the perfect stability of the dam.

It will be remembered that the dam is built of a species of hard slate rock—not the laminar slate with which our houses are roofed, but something much more compact. This slate is worked at the quarries, and brought down to the embankment. It would be impossible to dress all the blocks, and accordingly the wall has been built of rough blocks bedded in and held to each other by cement concrete. Those who know of what cement is capable will understand that, if this work is carried out properly, and no vacant spaces are left, the dam must be virtually monolithic. It will be as it were composed of a single stone. Mr. Hawksley doubted that sufficient care was taken to secure this condition. Sir Andrew Clarke had a shaft driven down into the heart of the work, 5ft. by 2ft. 6in., and found nothing to confirm Mr. Hawksley's doubts. Sir Andrew finds the geological conditions to be singularly favourable. He has satisfied himself that there is in the design an unusually large margin of safety, in whatever way the assumption as to the distribution of stress may be made. He has closely inspected the workmanship and materials, both as now employed and, by means of samples, at various stages since the commencement of the work. Samples of concrete, obtained in the course of the excavation of the shaft mentioned above, have been tested under pressure, the minimum resistance given by any sample being 198·7 tons per square foot, and the mean of fifteen samples 289 tons per square foot. He caused a series of questions to be addressed to the resident and assistant engineers, inspectors, and gangers, which, with their answers, are appended to the report. These answers may be summarised as follows:—At the quarry the bottom beds of the stones are dressed level and free from twist, and from any points which might cause an uneven bearing; at the sides and ends no overhang of more than 12in. is allowed; the upper faces are dressed with the hammer until sharp points are removed. After leaving the quarry, and before being set, some of the stones are reduced in height, and sloping stones are benched to suit adjoining work; any stones found with unduly sharp tops are dressed off to give a foot of bearing on the top surface. In setting the stones, a level bed of concrete and macadam, previously prepared, is thoroughly cleaned by washing and brushing; a bed of fine mortar 2½in. to 3in. thick is spread over this, and the stone is then bedded level and driven down with mauls. Care is taken that the stone does not touch adjoining ones. The joints are formed with concrete rammed solid with macadam by means of punners and swords. All the witnesses, sixteen in number, are unanimous in saying that no change has taken place since the commencement of the work in the above procedure. "From my own inspection," says Sir Andrew, "I am satisfied that this is the case, and that the precautions adopted, and the methods used, for insuring sound, good work are now, and have been from the commencement, such as to place beyond any question the solidity and uniformity of the masonry." To sum up, he is of opinion that the building of the wall is being well and skilfully carried out, and that the section is so enormously in excess of actual requirements, as evidenced by comparison with other existing masonry dams, that nothing short of an earthquake could possibly disturb it. It would be interesting to ascertain the amount of deflection of the top of the dam caused by the water pressure when it is filled. The deflection of the great Indian dam at Karakvasla when incomplete and about 70ft. high, with 50ft. head of water, was ascertained to be ½in. in a length of about 500ft.

The report prepared by Mr. Russel Aitken is more elaborate, but not less reassuring. Mr. Aitken has devoted special attention to the quality of the materials used, while Sir Andrew Clarke dealt with the way in which they were put together. Mr. Aitken employed Mr. Ogsten, a very able, practical chemist, to conduct a series of analyses. Mr. Aitken states that he has carefully worked out the stresses in the dam on the lines laid down in one of his lectures on reservoir dams, delivered at the Military School of Engineering, Chatham, in 1872, and he finds that the section of the Vyrnwy dam is more than ample, whether Professor Rankine's or his mode of calculating the strains be adopted. The maximum pressure on the masonry, which can be calculated with mathematical precision, is 7·7 tons per square foot when the reservoir is empty, and 8·6 tons when the reservoir is full. This calculation of pressure does not include the effect of the puddle on the inside of the dam and of the filling on the other side, which cannot be determined with mathematical accuracy, but it may be assumed that these pressures of 7·7 and 8·6 tons per square foot would practically be slightly exceeded. Such pressures would be perfectly safe if rubble masonry and concrete in good hydraulic lime mortar had been used; but when rich Portland cement mortar has been adopted the cross-section is abundantly strong. The stone (slate) of which the dam is built stands an average pressure of over 800 tons per square foot, and the mortar stands, after two years, 275 tons per square foot, whilst the concrete, taken out at the bottom of the experimental well-hole in the drainage tunnel sunk into the concrete, made with two to one mortar, stands between 200 and 300 tons per square foot before cracking or showing any signs of failure. The greatest weight per square foot on any part of the masonry is, therefore, only 3 or 4½ per cent. of the actual crushing strain of the cement concrete, and 1 per cent. of the crushing strain of the slate of which the dam is actually built. "Such large factors of safety are unusual in engineering, and reflect the greatest credit on those who are responsible for the execution of the work and for the selection of the materials used therein." In all this it will be seen there is nothing to support Mr. Hawksley's views. Indeed, there is practically only one point in the construction of the dam actually criticised, namely, the way in which water is drawn off for compensating purposes. In other words, the outfall culverts.

"The two outlet pipes," says Mr. Aitken, "each of which is taken through the dam itself, are not in my opinion the best mode in which the objects aimed at might have been attained. As I say in my lectures before referred to—'by far the best way is to take the outlet pipe through a tunnel in the solid at either side of the dam; by this means all danger is avoided.' When the water rises in a reservoir, the stone dam bends slightly, and one object is to get this bending as nearly uniform as possible from each side to the deepest part of the dam where the deflection must be greatest. The disturbance caused by two holes which are practically each 20ft. in diameter, part of which, no doubt, are filled with brickwork, must cause a disturbance in these strains and a consequent variation in the uniform deflection of the dam when the reservoir is filled. I do not anticipate any danger to the dam from this cause, although, I fear, there will be a good deal of leakage along the joints of the brickwork of the arch, for a brick arch set in cement never can be tight, as the cement sets so quickly that the sides of the arch crack, owing to the settlement of the wooden centreing on which the arch is built. As a matter of construction, a straight joint right through the dam is bad and should have been avoided. The design of the outlets, although they in no way endanger the work, should be carefully revised, as, hereafter, they may give trouble from leakage."

After referring to the drains intended to deal with springs that may arise under the dam, which drains might have been dispensed with, Mr. Aitken sums up by saying, "The conclusions I have arrived at are:—(1) That the cross section of the embankment or dam is abundantly strong; and, as far as a most careful inspection of the work can enable me to arrive at a conclusion, the work itself is being carried out exactly as it was from the first, viz., in a substantial and workmanlike manner, and so that it will, when completed, answer the purpose for which it was intended. (2) The quality of work in the Vyrnwy dam is as good as it can be; and the tests show that it, and the material employed, leave nothing to be desired, and that no expense has been spared to attain this object. (3) That in the higher portions of the dam, where the pressures are below four tons per square foot, the amount of the cement in the work may, if desired, safely be diminished. (4) The designs for the outlet works for the compensation water should be carefully reconsidered. (5) The inside face of the dam should be covered with a composition of a mixture of cement, sand, and ground slate."

Having perused the reports, the essence of which we have laid before our readers, we naturally ask, as they will, on what basis did Mr. Hawksley's doubt rest? On this point we possess no information, and can therefore express no opinion. He manifested, however, a highly conscientious resolve to do his duty by the Corporation of Liverpool, and we are sure that no one will read the reports with more pleasure than will Mr. Hawksley. The Corporation of Liverpool have nothing to regret in the matter, and Mr. Deacon has every reason to rejoice, for the action taken by Mr. Hawksley has made assurance doubly sure that the Vyrnwy dam is all that the very highest engineering skill, talent, and science can produce, and we shall at last be able to boast the possession in this country of a masonry embankment which will compare favourably with the great works which have been carried out by French engineers—notably in the cases of the Furens and Settons reservoirs, which have been fully described in our pages.

EXPLOSIVES.

THE annual report of her Majesty's Inspectors of Explosives, issued a few days ago, possesses a feature of peculiar interest, in that it contains a review of the operation of the Explosives Act extending over a period of ten years. In looking back over the past decade, Colonel Majendie,

as chief inspector under the Act, accompanied by the two inspectors, Colonel Ford and Major Cundill, is able to draw attention to the extraordinary development of the trade in explosives, and the valuable fruits of legislative control in connection with this industry. Science has been busy in producing new and powerful compounds of an explosive character, and the use of these agents has increased in a marvellous degree. The licensed factories have been doubled in number since 1876, the licensed magazines have increased from 199 to 350, the number of registered premises has risen from 13,146 to 22,268, and there has been a great advance in the importation trade. The figures we have quoted are exclusive of small firework factories; and, coupled with the great increase in the manufacture and use of explosives, is the encouraging fact that there is a large reduction in the loss of life incidental to such operations. The average number of deaths per annum in connection with the manufacture of explosives in the three years 1868-70, when no system of inspection existed, was 43. In the seven years 1868-74, during part of which some amount of inspection was carried out, the annual average of fatalities was under 40. In the four years ending with 1874, during which inspection was exercised, though without the aid of any compulsory or regulating powers, the deaths averaged 37 per annum. In the eight years 1878-85, during which period the Explosives Act was in operation, the loss of life in the manufacturing process averaged little more than eight per annum, and last year the number fell to five. These results are by no means all that are placed to the credit of the Act. Apart from the actual manufacture of explosives, there are such matters as storage and conveyance, which are of the utmost importance to the safety of the public. Strange things were done in years gone by, when the law was lax, and the subject had failed to attract much attention. Even now there are some outrageous cases of recklessness, but they are more generally fatal to the parties immediately concerned than to the outside public. Inherently the danger was never so great as now, owing to the extension of the trade and the violence of the compounds which are manufactured. But the law has stepped in, and by the enforcement of proper regulations, has made the presence of explosive materials less perilous than in former years. Had things gone on as of old, it is difficult to say where we might have been landed by this time. Of course it is possible for law to be carried too far. But repression is one thing and regulation is another. Of the former we have an example in the case of many of the railway companies, who continue resolute in their refusal to carry dynamite and similar explosives. The result is that they still carry these compounds, but the transit is effected surreptitiously. The danger to the public is increased, as the dynamite takes its chance among the passengers' luggage, instead of being properly cared for in goods trains. The only advantage to the railway companies is that if an explosion takes place, they are not liable for damages. Whether this fact lies at the root of their policy with regard to dynamite, we cannot say; but that the public safety is prejudiced by the conduct of the companies in this respect is an assured fact, according to the testimony of Colonel Majendie and his colleagues. The case is on record in which one gentleman was found travelling by train with 300 lb. of blasting gelatine, partly stowed away in a smoking carriage. Other cases are cited, and it is only reasonable to suppose that they are mere samples of numbers that escape detection.

If the railway companies, for some reason or other, are over strict in their mode of dealing with explosives, the local authorities err very generally in the opposite direction. So far as they have anything to do with the Explosives Act, these parties are singularly inert. A conspicuous exception occurs in the case of the Metropolitan Board of Works. The officers of the Board are unceasing in their vigilance. There is an arrangement by which they have cognisance of explosives entering and leaving London at the various railway goods stations, as also of explosives on the river. In addition, a proportion of the carts of small country carriers are examined in their passage. The consignments in vans from the powder makers in the vicinity of London also receive attention. The report states that during the past year the officers of the Metropolitan Board have examined consignments of explosives representing an aggregate of no less than 1680 tons of explosive matter in transit through the metropolis. The fact that they have failed in all this large quantity to find any irregularities, except a few of an unimportant character, is fairly considered to prove that the vigilance exercised has an effect in preventing anything seriously wrong. Only three cases have come under the notice of the inspectors in which the local authorities out of London have taken action in regard to the conveyance of explosives during the past year. These were rather notable instances. At Berwick-on-Tweed a carrier left 50 lb. of dynamite in a stable at a public-house. In Cornwall, a man belonging to Redruth left a cart containing 13 cwt. of dynamite and 1500 detonators in the street, without anyone to take care of the perilous burden. In the third case a boy in the service of an Edinburgh gun maker was found conveying gunpowder along the streets in an open barrow. Not only in the matter of conveyance, but also of storage, the remissness of the local authorities is the subject of complaint on the part of the Government Inspectors. The authorities have lately been called upon to send in fresh returns, showing the number of stores and registered premises on their books. As on former occasions, so it is said now, these returns are open to very considerable criticism, and often disclose the greatest carelessness and ignorance of the Act on the part of these authorities. Some improvement is recognised, as the result of personal communication and a good deal of persuasion on the part of the inspectors, who in many cases have taught the local authorities what their duties really are. It is evident that it will be some time before Colonel Majendie and his staff will have gone over all the land, so as to instruct the authorities everywhere as to their responsibilities under the Explosives Act. It fails to be generally understood that the responsibility for the inspection and condition of the explosive stores is vested, not in the Government inspectors, but in the local authorities, who often appear to be in blissful ignorance of the fact. The registered premises, more than 22,000 in number, represent substantially the extent of the retail trade in explosives. Here, as in the case of the stores, the local powers fall short of their responsibilities, though showing some improvement. Two boroughs are specified in which the premises visited by the Inspectors are said to have been "about as bad as they could be," and are described as "proving the gravest neglect of duty on the part of the local authorities and their officers." It was found necessary to cause proceedings to be taken in no less than twenty instances in different parts of the country, and convictions were obtained in all cases but one. In respect to the general control of the manufacture and trade connected with explosives, apart from the question of the local authorities, it is satisfactory to learn that after ten years' experience of the working of the Act, the Government inspectors find their powers to be ample and satisfactory. In the exercise of these powers they have endeavoured to show due consideration for the interests of the trade as well as of the public. But a firm discharge of duty has been recognised to be the only proper mode of proceeding, while the inspectors have at the same time sought to win the confidence alike of employer and employed. We have a somewhat amusing picture of the consternation which the unexpected appearance of a Government inspector has sometimes created in a factory. The workpeople have been seen hurrying from shed to shed, rapidly sweeping up and clearing away materials, with an activity evidently begotten of the advent of an inspector. Of course the meaning of all this is readily understood, and the indications create a feeling of disappointment; but we are told it is perhaps even more discouraging when coming as a friend to be "received as an ogre." Happily, and especially during the past two years, such evidences of want of confidence are said to have been far less frequent.

Colonel Majendie's department continues to have the benefit of the valuable services and extensive experience of Dr. Dupré as chemical adviser. An interesting report from that gentleman is now given *in extenso*. Eight applications for the license of new explosives were referred to Dr. Dupré during the year, but in two cases only could he report favourably. An explosive submitted by Mr. Turpin consisted of a mixture of chlorate of potassium, tar, and charcoal, more or less finely granulated. The compound was found to be extremely sensitive to the action of combined friction and percussion, such as a glancing blow, and was, therefore, reported on adversely. Ammonia dynamite was another candidate for explosive honours. This consisted of thickened nitro-glycerine and nitrate of ammonia. But the two ingredients were apt to part company, and in warm weather the nitro-glycerine was ready to run loose, thus creating a very grave danger. The report was consequently unfavourable. Wood meal gelatine passed muster, and has been manufactured extensively, though through some want of care the results have not been entirely satisfactory. Etnite, consisting of asphaline with the addition of a small proportion of sulphide of antimony, was found to be over-sensitive. Kinetite in which nitrobenzol takes a leading part, possessed considerable merits, but these were neutralised by a tendency to spontaneous ignition. Forcite was defective in chemical stability. An explosive submitted by Mr. Brodersen, consisting of nitro-glycerine mechanically absorbed in gun-cotton, passed successfully through all the tests applied. Turpin's explosive, etnite, and kinetite, all contain chlorate of potassium. Dr. Dupré remarks that this chemical compound, on account of the readiness with which it lends itself to the production of powerful explosives, offers a great temptation to inventors in that line, and many attempts have been made to put it to practical use, but so far with only very limited success. The reasons for this are given, one being that chlorate of potassium is a very unstable compound. In the autumn an explosion took place during the experimental manufacture of a new kind of gunpowder invented by Mr. Nordenfelt. Experiments conducted by Mr. C. N. Hake, in Dr. Dupré's laboratory, showed a serious danger at one stage of the manufacture, due to the use of bi-sulphide of carbon.

The number of accidents by explosion and fire of which Colonel Majendie's department had cognisance during the year was 133, causing 31 deaths and injuring 74 persons. These figures are below the average. The most remarkable dynamite accident of the year was that which occurred at Larne. Nine years ago an old hulk named the Essequibo, which had been used as a dynamite magazine, was abandoned and lay at the mercy of the waves and tides. After the old craft had served all the nine years as a store of firewood for the neighbourhood, the remnant of the hull was visited by two men, who set to work to break up the iron pump which yet remained. It appears that in this pump was some nitro-glycerine, which had exuded from the dynamite in years gone by. The circumstance was wholly unsuspected; but as the men were striking the pump with a sledge-hammer there was a violent explosion, and the two men were killed. The incident may be taken in connection with the sinking of a floating magazine with 50 tons of dynamite and blasting gelatine at Holehaven, contiguous to the Thames. The cargo was ultimately recovered, except that a large quantity of nitro-glycerine escaped from the dynamite into the water, and mingled with the mud of the creek, "where it formed an exceedingly dilute and ever-weakening sort of dynamite." The blasting gelatine lost none of its nitro-glycerine, even where the submersion had lasted for two months, and it appeared to sustain no injury whatever, thus showing its superiority to dynamite in respect to its non-liability to be damaged by water. Concerning blasting gelatine and gelatine dynamite, the report tells us that the manufacture of these explosives has been actively pursued during the past year, but the results are not yet altogether satisfactory, and considerable quantities have been seized. Unless the prescribed tests are complied with, the issue of the material will have again to be suspended. Regret is expressed that any hitch should have occurred with regard to the production of a class of explosives which appeared to be rapidly advancing in public favour, and to promise a number of useful applications. We can only hope that in the course of the present year better progress has been made with this class of explosive.

LEGISLATION AND ELECTRIC LIGHTING.

It has long been held, and it has often been said, that nothing but the state of the law prevents electricity from playing an important part in the lighting of towns. There is, we are assured, plenty of money ready to be invested in schemes for illuminating streets, and squares, and public buildings, and houses; but no one will invest while town councils and corporations can buy up installations before they have made an adequate return to those who have invested capital in constructing them. It is hoped that a change will be made in the law, and Bills have been brought before Parliament for the purpose. Nothing has been heard about them recently, because the Irish question has engrossed the entire available political energy of the nation. It is, however, worth while to consider whether any reasonable change in the law can enable electricity to supplant gas. No doubt exception will be taken to the words "supplant gas," and we shall be assured that gas will not be ousted, only its use will be altered. It will be employed for heating purposes and to produce motive power. We must take this assertion *cum grano salis*. If a great city or a small town is lighted by electricity instead of by gas, it is not easy to see how the demand for gas can remain unaffected; and we have no doubt at all that, under the circumstances, it will be affected, and very seriously affected. This, however, we may suffer to pass; only it must not be forgotten that the gas companies will range themselves against electric light companies, and put difficulties in their way. Let us suppose, however, that legislation becomes very favourable to electric lighting, and see whether we shall be any nearer to success.

We have not the least doubt that if the law were altered, a number of companies would at once spring into existence, having for their object the construction of installations in towns and cities. It is very easy to get money for any undertaking recommended to the public by respectable men of sufficient standing. But the question still remains, How far can any alteration in the law affect the position of affairs? As matters stand now, electric light companies have plenty of time before them for earning dividends or losing the whole of their capital. They have opportunities in plenty for proving that their undertakings can pay, provided they do pay. Of these opportunities they have not availed themselves, and we know that the history of the movement, taken in conjunction with scientific facts, proves that so long as gas can be had for half a crown per thousand feet, electricity cannot compete with it commercially. So far as is known, under the most favourable circumstances, incandescent lighting costs as much as gas at five shillings the thousand feet, and it may cost a great deal more. Arc lighting is, light for light, much cheaper than gas, but the most has not been made of arc lighting. On the contrary, so much has been done to discredit it, that incandescent lighting is certain for a long time to come to be imperatively demanded in all schemes for street lighting in Great Britain. This means cost; and in one word it may be said that electric lighting is too dear to find favour with the public. In places where gas is also dear it stands a good chance of adoption; but such places are small, and few and far between.

The success or failure of the electric light in the future thus turns not on legislation but on cost. If the cost of producing the light can be diminished, then all may be well. If it cannot, then there is no future before the electric light in this country which will justify the formation of large companies. We do not express any opinion as to whether the cost can or cannot be reduced; that is a question which we are not called upon to deal with in this connection. The fact, for the acceptance of which as a fact we contend, is that electricity cannot compete with gas in cost, and that unless it can be made so to compete, it cannot be made to pay. It is well known that the only chance of reduction in cost which electricity has lies in its extended adoption, but that adoption cannot possibly be secured unless it can be shown that such adoption will be to the distinct advantage of those who take it. Numerous attempts have been made to light districts and towns, and they have one and all failed. The history of the lighting of Holborn with the incandescent light, and of the Embankment and the City with arc lights, is well known. Of the original companies formed in 1881 few remain. It is easy to say that their arrangements were not perfect, and that money was wasted. All that is quite true. But if money had not been wasted, and the arrangements had been as perfect as possible, the result would have been the same. The electric light could not compete with gas in price. It remains to be seen whether it ever can be made to compete in this country. No better illustration of the effect of the price of gas on electric lighting can be had than is supplied by America. In that country gas is very dear—about three times as dear, indeed, as it is with us—and arc lighting is employed on a very extensive scale to light towns and cities. For the most part, mast lights are used, and the result is pronounced satisfactory, although arc lamps are freely employed of so indifferent a quality that their use would not be tolerated for a moment in this country.

But although for general lighting purposes we see little hope that electricity will be found suitable, the contrary is the case as regards small installations. The electric light will always be popular as a luxury. It can no more compete with gas than beer can compete with champagne; but for all that very large quantities of champagne are drunk. The use of electricity is rapidly extending in private houses, in ships, and in factories. Makers of electrical plant are very busy, and no doubt our readers would be surprised to hear how many dynamos in the week some of the leading firms are turning out. But all this is entirely independent of the Legislature. It is a line of business that will pay for pushing, and it will

extend, and with due care prosper, especially if those engaged in it do not indulge in the agreeable trade operation graphically entitled "cutting each other's throats." They will also do well to avoid committing financial suicide by charging too much. Legislation might very well be allowed to sleep at present, and meanwhile every legitimate effort should be made to reduce the cost of electric lighting, and to impart to it that flexibility and certainty which it has rightly or wrongly the reputation of lacking at present. There is still plenty of work to be done by the electrical engineer; but its legitimate amount will, we think, be very little affected by Acts of Parliament.

MECHANICAL WORK IN THE CHEMICAL TRADE.

THE era of low prices and the competition between processes are bringing about a more general adoption of mechanical work in place of hand labour in the chemical trade. On the Tyne the industry is still of very great importance; but the alkali manufacture by the old Leblanc process meets at present with the very fierce competition which the growing use of the ammonia process at home and abroad brings about. Hence the attempt to use machinery more in the trade; and now three kinds of mechanical decomposing furnaces are at work in three different chemical establishments on Tyneside. In one instance the Jones furnace is exclusively used, having banished the older hand furnaces entirely. In a second establishment the Mactear furnace is employed, and four of these do the whole of the work. And it is now stated that the St. Bede chemical works at East Jarrow—where an experimental furnace on a novel plan was erected two years ago—the whole of the decomposition of salt is effected by five mechanical furnaces, the use of the hand furnaces being abolished. It is the contention of the users of these furnaces that they produce more bleaching powder from a given quantity of salt; and it is to that article that the chemical manufacturers have now to look for profit instead of to soda crystals. It is also claimed that the sulphate produced by the mechanical furnace is purer than that made by the hand furnace. It is not so much a question of the extent of production with these furnaces, for the old hand furnace would decompose from sixty to sixty-five tons of salt per week, whilst some of the smaller of the mechanical decomposers treat only from seventy to eighty tons, though others of the larger ones treat more than double that quantity. But the labour employed is much less, and there is the possibility of the use of a cheaper quality of fuel, and in one or two of the mechanical decomposers it is claimed that there is also a saving in the use of sulphuric acid. In all it has been said that there is a gain of from thirty to forty per cent. in the use of the latter kind over the hand furnaces—that is to say, that the cost of decomposition is reduced to that extent. When it is remembered that the price of soda crystals has fallen from £4 in 1869 to about £2 at the present time, it is evident that there is a great need for the cheapening of all the processes of manufacture. One of these processes is that of decomposition, and it is evident that so large a saving in that process must tend to the reduction of the total cost of production; and a further reduction in that cost has been gained by the obtaining of salt in South Durham instead of in Cheshire, whilst another raw material—sulphur—has also been reduced in price, so that the Leblanc makers have a partial counterbalance for the fall in the selling price of soda. But it is only partial; and if that method of manufacture is to survive, it will only be by the further reduction of the cost of production. It is possible, indeed, that the price of soda may increase; but of this there is not at the present time much isgn, and thus every employment of machinery a distinct gain to the trade—which needs it.

THE BATH AND WEST OF ENGLAND AGRICULTURAL SHOW.

THE Bath and West of England Society's Show on the Durdham Downs, near Bristol, and nearer Clifton, is one of the largest ever held by this successful Society, and is one which shows how very highly its gatherings are esteemed by the agriculturist, and by all those who supply his requirements. Agricultural engineers and implement makers are there in numbers and in quantity of exhibits which equal the array of the Royal Agricultural Society, and popular appreciation of the energetic action of the Society is shown by the fact that the number of its members is increasing, while, as we mentioned last week, the members of the Royal Agricultural Society are decreasing very rapidly, the reduction being no less than 173 last year. The Bath and West of England Society has now reached a level which is favourably comparable with that of the Royal Society—at least, so far as its shows and its public work are concerned. At one time this would have been almost impossible, but conditions have been altered. The shows of both Societies are now on exactly the same footing, and as one is held about a month earlier than the other and in a different part of the country, there is nothing to prevent the equality of the two Societies in the positions they now hold, or, at all events, in the *rôle* they now play, namely, that of a fair. The gipsy and travelling clown element is absent, but as an outdoor collection of things to be exhibited and sold, these shows are the modern representative of the old fairs, everything being under one management, and visitors making one payment instead of payments to numerous exhibitors. The modern fair differs from that which it has displaced chiefly in the amount of education and practical application of science displayed, and most of this shows itself in the engineering parts of the show. Substantial encouragement in this direction has, however, now ceased, and as fairs or markets, the shows of the two Societies must be admitted equal; except for the bad weather the Bath and West might certainly have expected this year much greater patronage than the Norwich meeting. The scientific and experimental element which distinguishes the modern show is this year more especially exemplified at Clifton by the results of the ensilage experiments. On this subject the Society has been doing important work, and has arrived at definite results. The only regret that machine-makers will feel when they learn the results of the experiments, is that chaffing the crop does not appear to offer or secure any advantage. Simple and effective means of pressing in silos are, however, required, and will, no doubt, be extensively used. The Royal Agricultural Society has also been at work on this subject, but it is because this Society has ceased to do any noteworthy work of this kind, as illustrated by the trials of years past, that it has fallen to the position of a Society chiefly known by its organisation of a yearly fair or market for the exhibition and sale of cattle and pigs and agricultural machinery, the costs being chiefly paid by the makers of engines, machines, and ploughs, and by visitors of the holiday-making kind. The Bath and West of England Society has been awakened to this fact, and is, under its present management, breaking ground in several directions, and it appears to be the intention of the Society to do as much experimental work as its funds will permit, and to add explanatory lectures to its exhibitions. This year the council has made arrangements by which the makers of mowing and reaping machines and implements may be shown at work, and tickets are granted to exhibitors for re-admission to the show, of those who go out to see these implements at work. Except for the very bad weather that has so far attended this meeting, it will no doubt record greater progress during the present than in the past year. To some of the articles exhibited we shall refer in another impression.

PATENT LAW AMENDMENT.

THE Lord Chancellor's Bill "to remove certain doubts respecting the construction of the Patents, Designs, and Trade Marks Act, 1883, so far as respects the drawings by which specifications are required to be accompanied," is a measure which has been rendered necessary to cover the bungling of the Board of Trade officials. For a long time past these gentlemen have been advising their clients that it is possible to utilise the drawings filed with the provisional specification for the purposes of the complete specification. Persons have been informed that the words, "the drawings referred to are those lodged with my provisional specification," would be quite sufficient, and that the expense of preparing another set of drawings for the complete specification would thus be saved. It will be a matter of astonishment, even to those whose acquaintance with patent law is limited to a knowledge of elementary principles, how any clerk in the office should have been ignorant of the rule—often laid down by the Courts—that a specification must be complete in itself, and that no other document can be called in to explain the nature of the invention claimed. The Bill consists of two clauses only, and simply enacts that it shall be lawful to refer in the complete specification to drawings filed with the provisional specification; and further provides that the validity of patents heretofore sealed shall not be disputed on the ground that the complete specification was unaccompanied by drawings, but only referred to those lodged with the provisional specification. That such a measure is highly necessary to settle the validity of existing patents admits of no doubt, but this continued "tinkering" of the Patents Act is to be deprecated. This is already the second amending Act to a statute which only became law in August, 1883.

LITERATURE.

Differential and Integral Calculus. Prof. A. G. GREENHILL. Macmillan and Co., 1886.

PROF. GREENHILL'S experience at Woolwich has taught him the mathematical needs of engineering students. This book is better suited to satisfy such needs, and those of students of physical science in general, than the other text-books on the calculus that have come under our notice. The greatest advance seems to lie in this, namely, that the student is not called on to forego the study of the useful elements of integration until he has completed in full detail all the ramifications of the study of the differential calculus. A great deal of the latter the practical student will never make any use of. If he applies the calculus at all, he must use simple integration almost from the outset of his scientific applications. There is no difficulty of any kind in carrying on the two parts of the calculus simultaneously, and it is really a great hardship to the practical student that he cannot find treatises to help him in doing so. From an educational point of view there is great advantage in this method. The student learns early the chief object and utility of the calculus, and consequently takes a more eager interest, and is inspired to greater efforts and greater belief in the benefit he is likely to derive from his efforts. Again, there is no study in which practice of the art is more necessary than that of the calculus. Now, by carrying on the integral side by side with the differential, the field of apt and interesting illustration and example is enriched and extended in an immense degree; it becomes, in fact, at once fascinating to every mind endowed with scientific tastes.

Secondly, this book gives geometrical illustrations and proofs of all the most important results. This method of proof is so much more easy and convincing to many minds that we regret that it has not been carried a good deal further than it has been. Thirdly, the most important and useful results are gathered together into tables, which will be of much use for reference. We would suggest that this feature also might be further developed in a future edition, and if all these tables were collected together at the end of the book they would become still more useful. Every one habitually using the calculus should have beside him as complete tables of reference of this sort as he can possibly get. Again, elliptic and hyperbolic direct and inverse functions are dealt with along with and in correspondence with the ordinary circular functions. The extra difficulty so introduced is very small, while the completeness and symmetry of students' knowledge is greatly added to. The explanation of many modern physical applications is another important and useful feature of the book.

BOOKS RECEIVED.

Annual Report of the Board of Regents of the Smithsonian Institution for the Year 1883. Washington. 1885.

School Electricity. By J. E. H. Gordon, B.A. London: Sampson, Low, and Co. 1886.

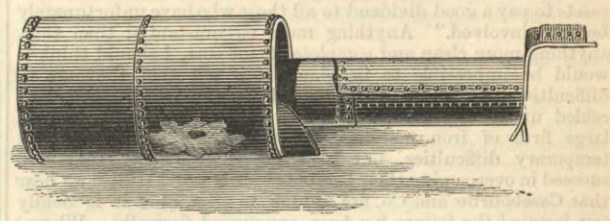
Cours de Machines. Par M. Haton de la Goupilliere. Tome premier. Premier fascicule, Hydraulique et Moteurs Hydrauliques. Paris: Ch. Dunod. 1886.

Tables for Calculating the Cubic Contents of Excavations and Embankments by an Improved Method of Diagonals and Side Triangles. By J. R. Hudson, C.E. Second edition. New York: Wiley and Sons. London: Trübner and Co. 1886.

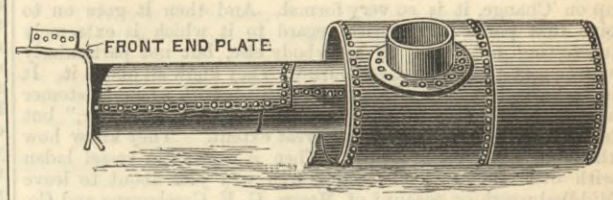
Iron and Steel Manufacturers of Great Britain, and Hand-book of British Iron and Steel. Compiled by H. W. Griffiths. London: *Iron Trade Exchange Office.* 1886.

THE EAST-END BOILER EXPLOSION.

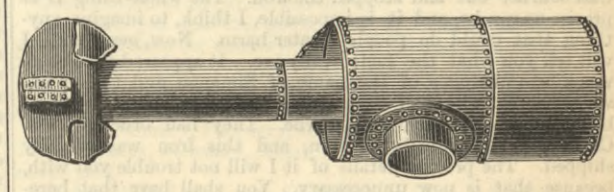
ON Monday last a boiler explosion took place in the East-end of London, causing the instant death of two men, dangerous injury to two, and injury to several others, more or less serious. The boiler in question was the property of Mr. Mattison, bedding manufacturer, carrying on business in Rhodeswell-road, Stepney. The premises comprised three houses and shops fronting on to the street, and a large three-floored building behind. The machinery was driven by an engine and boiler situated in the basement of the front buildings. Everything went on as usual during the forenoon, and the explosion took place about fifteen minutes subsequent to the start after the dinner hour. The whole of the front buildings is completely wrecked, as much so as if a large quantity of gunpowder had been exploded in them. As is the usual case with such disasters, the men whose evidence would be most valuable, namely, the fireman and man in charge of the engine and machinery, were killed on the spot. It is remarkable that a greater number of lives were not sacrificed, as the explosion took place close alongside a busy thoroughfare, and the disaster supplies one more example of the dangers to which the public are exposed as they pass through some of the streets—dangers hidden from view, and absolutely beyond the control of any save those responsible for the safe condition and working of steam boilers situate close to public thoroughfares. We give rough but sufficient sketches of the boiler. It was an ordinary Cornish boiler, 14ft. long and 5ft. in diameter, the flue being 2ft. 9in. diameter. The shell was made up of four rings of plates single rivetted in the ring seams. The back end of the flue is made of two plates, a crown plate and a bottom one, both of the same breadth apparently, and the left-hand longitudinal seam of rivets, looking forward, is on a level, or two or three inches above the level of, the top of the grate bars, the other being the same below them. A diametric line across the flue would pass apparently through the centres of the rivets and form an angle of about 20 deg. with the horizontal level of the grate bars. As will be seen by the illustration, there is a steam dome of the ordinary flat top shape on the third ring of the shell counting from the back. The boiler was provided with three lever safety valves, one on the steam dome and a pair of valves on a forked casting secured to the shell; all three were accessible, and their loads could be altered without difficulty. There was a steam gauge, supposed to be correct at the time of the explosion. The back end plate had but one gusset stay situate directly over the flue; it was secured to the back plate by a pair



ELEVATION — LEFT HAND



ELEVATION—RIGHT HAND



PLAN

of angle irons, the gusset having been put between the angles and secured with five rivets. There were no stay rods or bars longitudinally; neither are there any cross tubes in, or stiffening rings on, the flue. The boiler was purchased about three years ago by Mr. Mattison, second-hand; he had it examined at the time of purchase by an engineer. The previous history of the boiler, or who made it, is not as yet known. As far as the condition of its remains at the time we visited it enabled a judgment to be formed, the shell plates seem originally to have been $\frac{3}{8}$in. thick. The two front rings of the shell do not seem to have sustained any injury. The boiler appears to have been set in the usual way on two seating walls. The two back rings of the boiler are nowhere to be seen, portions of them have evidently been blown away to some distance, and perhaps other parts are buried in the ruins of the building. The first rip seems to have taken place in or close to the third ring seam of rivets, as the rivets remain intact, the second ring plate being simply torn away from them, a small fragment of the second ring, just about where it rested on the seating wall, still remains, and is much corroded. With rust and scale on it, it was not more than $\frac{1}{4}$in. thick in all, and if these are removed there cannot be more, probably not as much as $\frac{1}{8}$in. thick of actual plate. The surface of the third ring plate on the same line is also corroded, there being large scales needing little stress to peel them off. This patch of corrosion is about 8in. or 10in. long by 3in. or more wide. As the remains of the boiler lay when we visited it, the corresponding parts of the shell plates at the other side were buried in rubbish, and therefore no opinion can be formed of their condition till the shell is cleared for examination. As will be seen from the illustration, the two back rings in exploding tore away from the end plate, which will be seen to be bent back to a right angle above the flue. The gusset is gone with the ring plate, and the bending of the end plate made two cracks in the back of the bend, one at each side of the flue. The flue itself is in perfect condition in every way. It seems new, and was probably put in the shell before the boiler was sold as second-hand. There is not the least indication of shortness of water, the flue is perfectly clean, and, as far as can be seen, so is the shell. The workmanship of the boiler seems to have been good all round. Mr. Mattison informed us that the boiler was worked at a pressure of from 25 lb. to 35 lb. per square inch—a very moderate pressure for the boiler when in good condition. He never had any trouble with it, no leakage, no need for repairs, and the boiler was not driven or overworked. Of course, as the affair is *sub judice*, we must for the present refrain from comment upon it. The Board of Trade inquiry began on Thursday, but no expert evidence is yet available. The testimony supplied by the boiler is as usual, that the explosion was caused by weakness due to corrosion.

METALLIC SLEEPERS.

ON page 438 we give the first of a series of engravings of the metallic sleepers described in the report of a technical commission of the Society of German Railway Directors.

LEGAL INTELLIGENCE.

IN THE HIGH COURT OF JUSTICE—QUEEN'S BENCH DIVISION.

Yorkshire Spring Assizes, Leeds, Wednesday, May 19th, 1886.

Before Mr. Justice Cave *and a* Special Jury.)

Casebourne and Another *v.* The Engineer Newspaper.

[*Transcript from the shorthand notes of Messrs. Corfield and Hersee, 22, Chancery-lane, London.*]

Mr. Waddy, Q.C., and Mr. Robson appeared for the plaintiff; and Mr. Lockwood, Q.C., M.P., and Mr. Cyril Dodd were counsel for the defendants.

Mr. Waddy: May it please your Lordship, gentlemen of the jury, in this case my clients, the plaintiffs, are engineers, carrying on their business at West Hartlepool. The defendants are the proprietors of a newspaper which, as I am given to understand, has a very wide and influential circulation, especially among persons belonging to the same trade and profession as that to which my clients belong. The newspaper in question is called The Engineer, and has a circulation not only in this, but also in other countries. What we complain of is a paragraph that on a certain day appeared in The Engineer. I will read it through to you without note or comment, and then I will tell you the circumstances under which it arose, and ask you to observe how the language of this libel is so framed and shaped as to entirely misrepresent the real facts and be about as damaging as it can be:—"The North of England."—("From our own correspondent.")—"The failure has been announced of Messrs. G. E. Casebourne and Co., iron merchants, West Hartlepool. A heavy bad debt which they had made with a large customer at Genoa is said to be the cause. Two or three Cleveland firms will suffer, but not to any great extent. A vessel laden with over 1000 tons of section iron was just about to leave Middlesbrough on account of Messrs. G. E. Casebourne and Co., when she was stopped by the manufacturers. It is thought that there will be sufficient assets to pay a good dividend to all those who have unfortunately become involved." Anything more circumstantial than that, anything more clean and complete of the sort, I should think it would be impossible to imagine. It is not that they are in difficulties. It is not, as you and I have sometimes seen, concealed under any cloud; it is not, "we regret to hear, that a large firm of iron merchants in the North appear to be in temporary difficulties, but it is hoped eventually they will succeed in overcoming their troubles." It is worse still; "we hear that Casebourne and Co. are coming to grief," but it is boldly put forward the failure has been announced formally. Where? I suppose the *Bankruptcy Gazette*. Announced where? Posted up on 'Change, it is so very formal. And then it goes on to give that particularity with regard to it which is extremely interesting no doubt to everybody else, but not particularly satisfactory to Messrs. Casebourne. They know all about it. It is "a heavy bad debt which they had made with a large customer at Genoa." "Two or three Cleveland firms will suffer," but luckily for them, "not to any great extent." They know how the thing has come to a head. Then it says: "A vessel laden with over 1000 tons of section iron was just about to leave Middlesbrough on account of Messrs. G. E. Casebourne and Co. when she was stopped by the manufacturers," who had found Casebournes out and stopped the iron. The whole thing is as precise as can be, and it is impossible, I think, to imagine anything that could do people greater harm. Now, gentlemen, I will tell you what the facts really are. It appeared that there was a firm in Genoa of the name of Simango and Co. They were people who had been doing a considerable amount of business with Messrs. Casebourne. They had ordered from Casebourne a quantity of iron, and this iron was actually shipped. The precise details of it I will not trouble you with, because that is now unnecessary. You shall have that hereafter; but I want now simply to give you a broad outline of the case. Messrs. Casebourne themselves heard that the Genoa firm had come to grief, and accordingly Casebournes themselves got an injunction to prevent the ship, which had got her papers complete, from clearing out and marching off with the cargo which Casebournes were buying from a firm of Dorman, Long, and Co., and they would have to pay Dorman, Long, and Co. for this iron which they were selling to Simango, and which they naturally wanted to stop. But inasmuch as there would be a large amount to be paid to Messrs. Dorman, Long, and Co., from whom they had purchased the iron, and they could not recover the money because of the Chancery proceedings, it is clear, for some time, and although they would save their money eventually, they would be out of pocket to the extent of the whole 1000 tons of iron. Under these circumstances Messrs. Casebourne did what perhaps you would think any person of honour and respectability would do—that is, they determined they would immediately state these facts to the two or three persons who were alone creditors of theirs to any extent, and have a private meeting of these two or three persons and tell them the position they were in and see what they thought. Accordingly they wrote a private letter to the three persons, Messrs. Fry, I'Anson, and Co., of Darlington, and two others whose names I forget; but it is unimportant as to which of these three persons they sent their private letter, and this is the whole foundation for that paragraph which was—

We very much regret to inform you that, owing to a heavy loss, we are unable to meet our engagements. Our creditors are only three, viz, Messrs. Dorman, Long, and Co., Middlesbrough; the owners of the West Hartlepool Ironworks; and Messrs. Fry, I'Anson, and Co., Darlington. As we wish to lay a statement of our affairs before you, we shall feel greatly obliged if you will meet at the offices of Messrs. Dorman, Long, and Co.

These three gentlemen met them, or persons from each of these three firms; they talked the matter over, and they saw that the matter was all perfectly straightforward. A gentleman of the name of Gladstone, a member of one of those firms, was deputed to go over to Genoa and to get as much as he could out of Simango by way of dividend, and to arrange the matter generally, which he did, and there the whole matter ended. That is one thing, but it is a very different thing, and moreover that was a private arrangement which the world had nothing whatever to do with, which nobody in the world should have the right to say a word about, but which is here changed into "the failure is announced of Messrs. G. E. Casebourne and Co." I need not read it through again. The result of this was that directly this happened my clients were, I will not say surprised, but indignant at this, and accordingly through their solicitors they immediately wrote to the proprietors of The Engineer on the appearance of this week's issue, which was on the 8th of January. This is what they wrote—

The Proprietors of The Engineer, 163, Strand, London.

Gentlemen,—I have been consulted by Messrs. G. E. Casebourne and Co., iron merchants, West Hartlepool, with reference to the statements contained relative to them in your issue of last week, and which I am instructed to say are untrue.

Messrs. Casebourne and Co. have not failed. They made a bad debt, and the vessel you mention was stopped by them by an injunction obtained at their instance from the High Court,

My clients having large business connections, both in England and on the Continent, I need hardly say that such statements as these, disseminated, as they will be, through the English and continental press, are calculated to do them immense harm by entirely destroying their credit. It is difficult at present to estimate the damages which will ensue, but my clients think that £10,000 will hardly be sufficient to cover what they will ultimately lose, and have instructed me to institute an action against you for that amount.

I shall be glad to know the names of your solicitors.

and so on. The mischief that is done by a thing of this sort cannot be repaired by an apology, because that may happen without any subsequent blame attaching at all to the editors of The Engineer, which did happen in this case. Some malignant people, because there was no doubt about it, thought it desirable to send copies marked in red ink of this thing to their customers. The Elsinore Company and others, foreigners, to whom, of course, afterwards the contradiction should have come, never got it, and the result of that is that my clients' credit was irretrievably damaged. Under these circumstances they get an answer from the office of The Engineer, which also I will read—

Office of The Engineer, 163, Strand, London, W.C.
13th January, 1886.

The Editor of The Engineer presents his compliments to Mr. Parrington and acknowledges receipt of his letter of the 11th instant. The Editor regrets exceedingly the statement referred to, which upon enquiry he finds from his local correspondents to have been written under a misapprehension of the facts.

That is quite certain.

It seems that Messrs. Casebourne's affairs were a matter of common conversation on 'Change, in consequence of the firm having taken some of their more considerable creditors into their confidence.

I believe I shall be in a position to call before you several persons who were men acting on 'Change at that time, and who will tell you so far as they know that it was never mentioned on 'Change at all; the whole thing was kept private and a secret, and I believe I shall be in a position to trace the precise channel of the man by man through whom they got the information which they afterwards made public, and which they got in a private way. "It was a common talk on 'Change"—that is the excuse.

The Editor repeats that he very much regrets the occurrence, and will, of course, be glad to give equal publicity to a contradiction of the report. He proposes to insert in a prominent place in this week's issue a statement in the form enclosed, if approved by Mr. Parrington's client; and doubtless with this reparation Messrs. Casebourne and Co will be satisfied. The Editor would ask for a reply by telegraph, as The Engineer goes to press on Thursday night.

That is just the whole tale over again. Gentlemen, you are bankrupts. We are nothing of the sort. Are not you? then I will insert a contradiction with which you will be abundantly delighted; who may see the first I do not know, and I don't care, and who sees the contradiction is a matter of equal insignificance and unimportance to me. It is sufficient to me that I have contradicted the report, and so rub up the whole sore over again. Now, gentlemen, accordingly what they did was they inserted this correction. If they were going to insert a correction—I don't know how it strikes you, but I should have thought that all they need have done was to say, we find that we were entirely misinformed with regard to Messrs. Casebourne and Co., and we exceedingly regret having put in a statement for which there was no proper foundation. But, gentlemen, with regard to newspapers I daresay you have observed infallibility is their foible—their weakness—they cannot be wrong, and if they have been wrong they must show you how near they were to being right. If they have said a thing they ought not to have said they cannot help telling people, "though we were wrong, yet after all there was some little ground for it." Now listen to what they have said. "Correction: We regret very much the statement made in the letter of our North of England correspondent which appeared in our last impression, to the effect that Messrs. G. E. Casebourne and Co., of West Hartlepool, had failed." That is all right. Now then, are they going to show there is no truth in this? No. "It appears that a large foreign customer of that firm had stopped payment, but we are informed that Messrs. Casebourne and Co., beyond being sufferers by the loss"—whose business was that?—"are not affected in their business, and that the steamship to which reference was made was not stopped by a creditor, but by Messrs. Casebourne themselves. We repeat our expression of regret that the passage in question should have appeared in our columns." Why on earth, when they were about it, they could not just simply put in a simple apology and have done with it, I don't know. That was the least they could do; but they must go on telling all the world that with which the world had no business—that Messrs. Casebourne and Co. were in the unfortunate position of having a large foreign customer of their firm stopping payment and were sufferers by it. Why they must stick that in, I declare for the life of me I don't know, except, as I said before, that newspapers have infallibility for a sort of foible. There it is. They may have the benefit of that apology, such as it is, and you will put all the weight on it which it deserves afterwards, no doubt, under the guidance of my learned friend. They send us a copy of that, to which the answer is telegraphed back—

We must leave it to your discretion what you publish by way of retraction; cannot accept it as reparation for so serious an injury.

Then on the 14th the letter is written, which I need not read, because it is practically an enlargement of the telegram. I do not read it, but I will put it in, because there is nothing to be kept back that I know of. Then there was some other correspondence which also will be put in, but there is one letter only which I propose to read to you, because I think it shows the spirit in which these gentlemen have been dealing with the matter, and because I think it will bear upon the manner in which you will deal with it. I will read one portion to introduce it. Mr. Parrington wrote:—"Mr. Head called on me yesterday." He was, I believe, the gentleman who was really responsible for this, the North of England correspondent, who got this information and then made it public in this way, and it clearly stated it was announced that they had failed.

Dear Sir,—

Casebourne and Co.

Mr. Head called upon me yesterday urging the acceptance of your retraction as complete reparation. I could only tell him that I would submit what he said to my clients, and take their further instructions, which I have done to-day. They, however, feel very strongly that they should have adequate pecuniary compensation, urging that at the very time when business and credit were most essential to them to enable them to repair their loss, they have, though perfectly solvent, suffered serious loss in both through the statement in your paper.

I am therefore sorry that I shall have no alternative but to issue a writ, and if you will let me have the names of your solicitors I will send it to them, to save any annoyance.

And so on, to which this is the answer:—

The Editor of The Engineer presents his compliments to Mr. Parrington. He is sorry that Messrs Casebourne do not realise—"

Do listen to this, because that is what strikes me as being about the finest thing I have heard for a very long time. "He is sorry that Messrs. Casebourne do not realise that the correction which appeared in The Engineer must be of infinitely more value to them than could the erroneous notice be harmful." I venture to stop there, that I may get my breath, because it is enough to take the breath of any man away. You start in a newspaper the statement that a man is bankrupt; a week afterwards you write to say, "I am sorry I said that he was bankrupt. The fact is, I find he is not actually bankrupt, but he has had a tremendously heavy knock, and beyond that, which perhaps he will get through, because that is what it amounts to. Then you say: "Now, my dear Sir, the thing I said afterwards when I said you were a bankrupt does you infinitely more benefit than the damage that was done to you by telling the whole world that you were." That is their notion, and in accordance with that they have afterwards taken into consideration, calmly, in the office of The Engineer, how much it damages people in good credit to spread over the world the news that they have failed in business. They have estimated, and they think that about £10 10s. is the damage it does to a man. Now, how absurd it is; but that is the amount which accordingly is paid into Court. Take the apology, gentlemen, if you like, as being the best apology that ever was made. They say the damage you do to a man by a thing of that sort is £10 10s. worth of damage. Then they avail themselves of the provisions of a statute, and they claim assistance through it which has been provided on behalf of newspapers; that when it can be shown that anything has been put in a newspaper that is defamatory, there are four different requirements to enable them to take advantage of the statute. The first is that it was put in without actual malice, which in this instance I do not seek to suggest; secondly, without gross negligence; thirdly, that there has been a full apology; and fourthly, that there has been full amends, and in that case the newspaper may be defended. That is quite right. Now, let us see. You know these people, "Our own Correspondents," get news of tittle-tattle—as was the case in this instance; according to their own version of it, even if it was true, thus they pick up news in any way that they can. This was simply something whispered about on 'Change, and without any further foundation than that they put in the formal announcement which I have read to you. They do it without searching: they do it without inquiry at the office of Casebourne's; without inquiry from anyone of these three people, who were the only persons concerned so far as I know; but at all events they do it without attempting to find out whether there was any official announcement of the sort; and I think you will say that has not been done therefore without gross negligence.

Now as to the apology, I think I have said all I want to say. Do you, gentlemen, think that that is a fair apology or not? Suppose it is for a moment. The fourth thing is that they should make amends. They have made amends from their point of view, and the amends they make is, as I have told you, £10 10s. They ask you to say that that is enough. It's a matter of fact that this was practically ruin to Messrs. Casebourne and Co.; is simply ruin. I would not go through the figures which I shall have to give you hereafter, but you will find from that moment their credit was stopped; and I shall be in a position to bring before you people who will tell you that they declined to give them credit afterwards, solely on account of that matter which appeared in The Engineer. You are men of business, and I need not tell you that that is simply fatal to any man. It was practically fatal to Messrs. Casebourne, and has produced for them the very worst consequences. Gentlemen, I ask you in this case to assess such damages as you think Messrs. Casebourne and Co. are entitled to for the injury which has been done to them in consequence of this libel which appeared in the defendant's newspaper. I will now, with the assistance of my learned friend, call the evidence before you.

Mr. George Edward Casebourne sworn: Examined by Mr. Robson. Q. You are an iron merchant carrying on business at West Hartlepool?—A. Yes.

Q. In partnership with Mr. Robinson, the other plaintiff in this case?—A. Yes.

Q. You have carried on business there for about ten years, I believe?—A. Yes.

Q. And in partnership you have carried on business for about three years?—A. Yes.

Q. Under the name of Casebourne and Co.?—A. Yes. G. E. Casebourne and Co.

Q. You have had considerable connections both in England and abroad with many persons in the iron trade?—A. Yes.

Q. And among your foreign customers was a firm called Samango?—A. Yes.

Q. Whereabouts did they carry on business?—A. In Genoa and Buenos Ayres.

Q. Now, I think at the end of 1885 you were under contract to supply a cargo of 1500 tons of iron to the order of Samango at Buenos Ayres?—A. Yes.

Q. And you purchased that cargo from Dorman, Long, and Co.?—A. Yes.

Q. I think I may lead as to this? While that cargo was being loaded, or after it had been loaded, Samangos dishonoured a bill which was current which you had got in payment for the previous cargo?—A. Yes.

Q. Did you then take steps to have this cargo stopped?—A. Yes.

Q. And it was stopped?—A. Yes.

Q. After that appeared in The Engineer of the 8th of January—this paragraph which you have heard read?—A. Yes.

Q. Before the appearance of that paragraph, Mr. Casebourne, you had been able to buy goods on credit from various firms?—A. Yes.

Q. After the appearance of that paragraph were you able to buy goods just as previously on the same terms?—A. No, the terms of payment altered. I was not able to buy on the same terms.

Q. Tell us the firms with whom you had been dealing in getting goods on credit. Give us some of their names.—A. Ray, of Sunderland.

Q. Just give us the names of some others.—A. Casper and Co., of West Hartlepool; the Stockton Malleable Iron Co.; the Steel Company of Scotland; and the Consett Ironworks.

Q. Let us take the Steel Company of Scotland, that is one of those you have mentioned.—A. Yes.

Q. Have they made any difference with regard to the terms on which they sold goods to you since the appearance of that paragraph?—A. At first they did.

Q. When the paragraph appeared did they make any difference with regard to the terms on which they sold you goods?—A. Yes.

Q. I think there is a letter of 14th January that you received from them?

Mr. Lockwood: I apprehend, my lord, that that is not the proper way to prove this. If my learned friend proves any communication from the Scotch Company it must not be by a letter written by the firm, but I think the representative of the firm should come and say the reason they did it.

Mr. Justice Cave: Yes. I don't think it can be done in that way.

Mr. Robson: Very well, my lord. Q. What terms had you previously with the Steel Company?—A. Cash on the 10th of the month following delivery.

Q. What variation did they make in their terms when you applied to buy goods from them after the appearance of this paragraph in the paper?

Mr. LOCKWOOD: Is that by letter? My learned friend is not entitled to it in that way—the communications that passed between them. Surely they must come and give direct evidence of what they did, and the reason why they did it.

Mr. Justice CAVE: He is asking on what terms did you do business afterwards?

Mr. LOCKWOOD: I suppose the contracts were in writing?

Mr. ROBSON: The question I am asking is this: What variation did they make in their terms after the appearance of that paragraph?—The witness: They required cash against invoices.

Mr. LOCKWOOD: I submit that that is not the proper way to prove it. If there were contracts, I suppose those contracts were in writing?—The witness: There were no contracts—they were letters, I suppose.

Mr. LOCKWOOD: Letters which constituted a contract?—The witness: Letters only.

Mr. LOCKWOOD: Those letters would no doubt be evidence if they were produced by persons who wrote them.

Mr. Justice CAVE: The whole question is, what caused this change in the terms?

Mr. ROBSON: Am I not at liberty to prove the simple fact, and leave the inference to be drawn by the jury, by proving that they refuse to supply goods on the same terms?

Mr. Justice CAVE: You had better confine yourself to general allegations at present.

Mr. ROBSON (to witness): I may take it there was some difference with regard to the dealing with those you bought goods from after the appearance of that paragraph?—A. Yes.

Q. With regard to the persons to whom you sold goods, had you any difference with regard to your customers after the appearance of that paragraph?—A. Yes.

Q. Tell us the names of some of the customers with whom you had generally dealt?—A. The Flensburg Shipbuilding Company.

Q. Your dealings with them during the previous ten years had been very considerable, had they not?—A. Yes.

Q. Can you give us any idea of what total your dealings with that company has been during the last ten years?

Mr. Justice CAVE: We cannot go into these details.

The witness: £200,000 or £300,000.

Mr. LOCKWOOD: My learned friend is not entitled to get this any more than the other.

Mr. Justice CAVE: That is what I was saying. The same point is involved. If you want to prove that a particular customer refuses to deal with him, you must formally prove it.

Mr. ROBSON (to witness): After the appearance of that paragraph were the remittances from your customer affected at all?—A. Yes.

Q. Tell us in what respect they were affected.

Mr. LOCKWOOD: No. That is the same thing. We cannot have that.

Mr. ROBSON: I submit I am entitled to prove it in this way. The appearance of a paragraph of this kind will make customers averse to sending remittances, because there might be some difficulty with regard to the trustee.

Mr. Justice CAVE: You cannot give the evidence in that way.

Mr. ROBSON: Very well, my lord. What other customers had you than the Flensburg Company?—A. The Elsinore Shipbuilding Company.

Q. And they have been considerable customers?—A. Yes.

Q. Have you had any dealings at all with the Elsinore Shipbuilding Company during the three months?

Mr. Justice CAVE: I have said over and over again that you are not entitled to this evidence.

Mr. ROBSON (to witness): Has there been any difference in the general amount of your sales during the last three months?—A. Yes.

Q. Have you your books here to show that?—Yes.

Q. Tell us what decrease there has been during the last three months as against the preceding three months in the amount of your sales.

Mr. LOCKWOOD: That is the same thing.

Mr. Justice CAVE: A general loss of business can be proved.

The witness: About one-tenth the first three months of this year compared with the last three months of last year.

Mr. ROBSON: The three months that preceded the publication of that paragraph were three times as much as those that succeeded it?—A. Yes.

Cross-examined by Mr. LOCKWOOD: Q. May I take it that you are comparing, in the figures you have given just now, the first four months of this year or the first three months with the last three months of last year?—A. Yes.

Q. May I ask you to compare the first four months of this year with the corresponding quarter of last year?—A. I shall have to get the books to do it.

Mr. Justice CAVE: I think we will adjourn now.

Adjourned until to-morrow at 10.30 a.m.

Mr. G. E. Casebourne recalled. Further examined by Mr. WADDY.

Mr. WADDY: My lord, I wish to correct a misapprehension which I am given to understand I gave rise to yesterday. I should have asked this one question. There was a letter which I read in my opening to Messrs. Fry, I think?—A. Yes.

Q. To how many persons was that letter sent?—A. To Messrs. Fry and I'Anson only—that is, one firm.

Q. The other two persons referred to are Dorman and Long—that is a firm?—A. Yes.

Q. I believe that Dorman and Long were the very people whom you consulted, who thought it desirable you should write that letter? Of course there was not one sent to them? The matter was verbally mentioned to Mr. Gladstone, the representative of the other firm, so that the one letter was the only letter sent out?—A. Yes.

Mr. WADDY: We will put them all in. Your lordship has a copy of the alleged libel and the correction?

Mr. Justice CAVE: Yes.

Mr. WADDY: Letter of December 29th to Messrs. Fry and Ianson—is that in? [Copy correspondence handed to the Court.] I will just state at once which letters I have read. There is December 29th, 11th January, 13th January enclosing the proposed contradiction which appears in my copy on p. 3, and there is a clerical error there; on about the fourth line it says, "It appears that a large foreign '*creditor*' of that firm." Of course that made it worse still; but I dare say that may have been a slip on the part of the party that wrote it. It is printed as "customer" afterwards, so I have no doubt that is what they meant. Then there is the telegram of the 14th January and the letter of the 14th, which is the expansion of that telegram; and the 15th January. And then, my lord, there is no other letter that I know of that is of any importance until the 21st January. There is one of the 20th I read as contradictory to the one of the 21st. I see there are several here of the 20th; but the one of the 20th which I put in begins with "Mr. Head called upon me yesterday," and the answer to it is, "The Editor of THE ENGINEER presents his compliments to Mr. Parrington."

Mr. LOCKWOOD: I was just going to ask the witness with regard to a comparison of the four months—give me your turnover for the first four months of 1886?—A. I thought it was sales you asked me for yesterday. I have not the turnover.

Q. No, this is turnover. Cannot you give me your turnover for those months?—A. We can get it from the books, but it was the sales I got out.

Q. Well I put it to you that your turnover for the first four months of this year amounts to £12,100?—A. Yes.

Q. And your turnover for the first four month of 1885 (that is, the corresponding period in last year) amounted only to £11,053?—A. Yes.

Mr. WADDY: You say "Yes." Is that so?—A. I dare say that will be correct.

Mr. LOCKWOOD: It is not an unfair way of comparison to compare the corresponding periods of one year the one with the other?—A. The turnover is an unfair way.

Q. My question was whether it was not fairer to compare corresponding periods in the year than to compare the beginning of the year with the end of the year?—A. Not with regard to the turnover.

Q. Now you have compared the last four months of 1885 with the first four months of 1886.

Mr. Justice CAVE: He says he has taken out the sales in the corresponding months, and that, at all events, will give us something.

Mr. LOCKWOOD: Have you taken out the sales in the first four months of 1885?—A. Yes.

Q. Will you give me those?—A. £10,600.

Mr. Justice CAVE: And the same period in 1886?

Mr. WADDY: £3020.

Mr. LOCKWOOD: What, for this year do you mean?

Mr. WADDY: Yes. I will put the accountant in the box presently.

Mr. LOCKWOOD: We will begin with the first months of 1886. What do you say your sales for the first four months of 1885 were?—A. £10,600.

Q. What do you say for the first four months of 1886?—A. £3020.

Q. Are your books here?—A. Yes.

Q. Are they made up for 1886?—A. Up to the present time.

Q. Up to what date are they made up?—A. The accountant will be able to say. I think they are made up to the end of April in this year.

Q. Now of the five firms that you have mentioned—Caspar and Co., the Steel Company of Scotland, Stockton Malleable Iron Company, Thomas Ray, and the Consett Ironworks—in 1885 what was the total amount of business you did with those five firms?—A. I cannot tell you.

Q. I will put it to you; it was £1648?—A. Yes; that might be correct.

Q. Out of a total amount of business done of about £46,000?—A. Yes, that may be correct.

Q. Then these five firms represent a very small portion of the business that was done in 1885 by your firm?—A. Yes.

Q. You have spoken of the Steel Company of Scotland, Limited. Have you a book in which you set out your contracts?—A. Yes.

Q. Can you tell me how long it is since you had any contract with the Steel Company of Scotland?—A. We only had letters; we had no signed contracts.

Q. Have you had any contract with the Steel Company of Scotland as shown by your books since 1881?—A. They are all contained in correspondence. There are no signed contracts; they are in letters.

Q. You mean then to say that you had dealings with the Steel Company of Scotland since 1881?—A. Yes.

Q. And will your books show that?—A. Yes.

Q. The accountant will be able to point that out to us, I suppose?—A. Yes.

Q. You do not complain, do you, of the notice these gentlemen put in their paper directly they had found they had made this mistake, which they very much regret?—A. Yes.

Q. Then may I ask you when it was sent to you for approval? Did you think the notice would do you any harm?—A. Yes; I think it would.

Q. Then, surely, it was sent to you for approval, was it not, before it was inserted?—A. Yes.

Q. Then if you saw anything in that which you thought was calculated to hurt you, do not you think you should have called the attention of these gentlemen to it?—A. The correction would call people's attention to the loss we had sustained who had not seen the first libel.

Q. At any rate, whatever it did, did not they write and submit to you the correction they proposed to make?—A. Yes.

Q. Do not you think that they were, at any rate, endeavouring to put into their paper a correction of which you would approve?—A. Yes.

Q. Then if they submitted to you a correction, of which you did not approve, why did you not write and tell them so? Do you think it was quite fair to allow them to insert this without one word saying you thought it would do you harm, and not to point that out to them, they believing that they were acting *bonâ fide*?—A. I believed whatever the correction they might put in was it was apt to do us harm.

Q. Did you want a correction to be put in at all?—A. I did not think it would do us any good.

Q. Did you want the correction put in?—A. Of course it might do good.

Q. Thinking it might do good, you allowed it to be put in?—A. And it might do harm; we left it to their discretion.

Re-examined by Mr. WADDY: Q. You said a short time ago that to take the turnover was unfair. Just explain that to my lord and the jury. I want to see what that means. Why is it?—A. A contract is made, my lord, for delivery over six or nine months. Therefore a contract made at the end of 1885 is being delivered in 1886.

Q. So that the turnover for 1886 would in reality, or at all events to a considerable extent, be the business that had been done in 1885?—A. Yes.

Q. You have been asked as to whether you have been having any business transactions with one firm since 1881.

Mr. LOCKWOOD: The Steel Company of Scotland?

The Witness: Yes.

Mr. WADDY: Look at that letter; did you receive that from the Steel Company of Scotland? [Handing same to the witness.] You were acting as brokers, were you not, very frequently—merchants?—A. Yes, merchants.

Q. Until this report got abroad did the Steel Company of Scotland or any of the other people insist on nothing?

Mr. LOCKWOOD: My learned friend is really now endeavouring to do that which was unsuccessfully attempted yesterday. He is evidently going to get from a letter put in the hands of this gentleman evidence with regard to some requirement made of him. I submit unless my learned friend lays the foundation of that, by showing that the action that was taken was the result of what the defendants did, this is not evidence against them.

Mr. WADDY: I propose, my lord, to do this. Until my learned friend put the specific question, I was not in a position to ask the question I proposed; and I did not think that I was in a position to ask it yesterday. Now, my learned friend has asked with regard to a specific arrangement made between this gentleman and one particular firm.

Mr. LOCKWOOD: I did not ask that.

Mr. Justice CAVE: The amount of business was all that was asked with regard to the particular firm.

Mr. WADDY: Yes, my lord, and what I propose to show is the loss that we have suffered.

Mr. Justice CAVE: You may show the difference between the two businesses—the business done with them in the corresponding period of 1885 and that done in 1886.

Mr. WADDY: Very well, my lord. We have given five illustrations yesterday.

Q. Was a large proportion of your business done in foreign countries?—A. Yes.

Q. To prove it in that way we should have had to bring people from various places abroad?—A. Yes.

The witness withdrew.

Mr. McInlay sworn, examined by Mr. WADDY:

Q. You are an accountant I believe?—A. Yes.

Q. You have examined the books of the firm?—A. Yes.

Q. I will only ask you about two questions: We have heard the account given by this gentleman, the last witness—have you made yourself acquainted with the character of their business?—A. Yes.

Q. You have, in fact, been their auditor for the last three years?—A. That is so.

Q. Be good enough to tell me, knowing the character of their business, does the comparison of the turnover give a proper indication of the damage done?—A. Not at all.

Q. I will not follow it further. What is the proper thing to compare to ascertain whether damage has been done them or not?—A. The proper thing is to compare the sales.

Q. The actual sales?—A. The actual sales. They may sell 10,000 tons at one time, but that 10,000 may not be delivered for six or twelve months.

Q. They make time bargains?—A. Yes, they make time bargains.

Q. Have you taken out the figure my learned friend has suggested as a fair one? I will put it to you at once. Have you or not taken out a comparison of the sales of the first four months of 1885 as against the sales of the first four months of 1886?—Yes.

Q. Will you kindly give me the figures?—A. The first four months of 1885 about £10,000, and the first four months of 1886 £3000.

Q. That is in round terms?—A. Yes, in round figures.

Q. Is this a business that has a season to it at all, so as to make the comparison of the last three months unfair as against the next three?—A. I can scarcely answer that question.

Q. I see that your comparison was of the last three months of last year against the first three of this?—A. It is so.

Q. It is suggested, and it may be rightly, that these are not fair times to take?—A. No.

Q. Is that so?—A. That is so.

Q. It is not fair?—A. No.

Mr. WADDY: Then, of course, I will not take it.

Cross-examined by Mr. LOCKWOOD:

Q. Could you tell me, going back to 1884, what the totals were of the sales for January, February, March, and April?—A. I could not.

Q. You could not tell me whether those were as much as £21,000?—A. I could not tell you that.

Q. For January, February, and March, 1884; and I give you 1885, January, February, March, and April, £11,053?—A. It is about that.

Q. And 1886 I give you £12,100?—A. That is the turnover, not the sales.

Q. Have you the books here?—A. Yes.

Q. Then please produce them. Just give me January, February, March, and April?—A. Of the turnover?

Q. No, the sales. Before you turn to the book, is it true that the books have not been posted since the 31st January?—A. Partly posted; but they are not all posted, I believe.

Q. Have there been any entries of goods made in the ledgers since that time?—A. Yes, in the cash book.

Q. In the ledgers, I said?—A. I am not sure as to the ledgers.

Q. You have had the ledgers before you?—A. Not for this year.

Q. So you do not know whether they contain any entries?—A. I only made a balance up to the end of last year. I examined the books up to the end of last year.

Q. Will you take January, 1886?—A. The contracts?

Q. The sales?—A. I cannot give you that.

Q. You cannot give me the sales for January, 1886?—A. No.

Q. Can you give me the sales for February, 1886?—A. No.

Q. Can you give me the sales for March, 1886?—A. I can only give them all together. I have not taken them out separately.

Mr. Justice CAVE: He says they are so much altogether.—A. I have not appropriated them to their particular months.

Mr. LOCKWOOD: Where did you get them from?—A. From the contract book and the delivery book.

Q. Is that the book from which you got them? [producing a book]—A. Part of it.

Q. Get the other book, please. I must have the materials because we have such a discrepancy here. Will you hand me the account?—A. The first contract was on the 5th March for 60 tons at £4 10s., that is £270.

Q. Were there none in January and February?—A. That is 1885 I am talking of.

Q. I beg your pardon. I was not asking you about 1885 at all, I was asking you about 1886.—A. I have got them in detail here.

Q. For 1886?—A. Yes.

Q. Let me look at it for a moment. [It was handed to the learned counsel.] You have not the dates here I see?—A. No, it was taken out roughly this morning.

Q. Was this only made out this morning?—A. Yes, it was only made out this morning.

Q. Now just let me understand, what have you included in this?—A. Plates and angles and other goods.

Q. Have not you included all goods?—A. All goods sold.

Q. Did these gentlemen do a commission business?—A. Yes.

Q. Then they purchase on behalf of others, I suppose.—A. Sometimes—not often, I think.

Q. Have you included in this January, February, March, and April all the transactions of the firm?—A. Yes, all the transactions of the firm.

Q. Both buying and selling?—A. Buying—selling, rather.

Q. Have you included all the transactions of the firm?—A. Yes.

Q. Both buying and selling?—A. Only selling there.

Q. In 1885?—A. In 1885.

Q. Have you included all the transactions of the firm?—A. Yes, as far as I know.

Q. Whatever they were?—A. Yes.

Q. Then that is the turnover, is it not?—A. No, it is not the turn-over, not at all.

Mr. Justice Cave: It may not actually come to anything until some time after. If you sold in January to be delivered all over the year you have part of it as you deliver, and only a small portion in the first four months.

Mr. Lockwood: Do you mean in 1885 you have merely taken the contracts for sale?—A. I have taken the actual sales made in 1885.

Mr. Justice Cave: In the four months of 1885 he has taken the actual sales made, and the same thing in 1886.—A. The same thing in 1886.

Mr. Lockwood: These figures here you say represent all the sales shown in the books?—A. Yes.

Q. Give me the books, please, from which you made this account. Have you the book there which will show the April sales—April this year? Have you included in your estimate for April all the sales for forward deliveries that were made in April?—A. 1886?

Q. Yes.—A. Yes.

Q. I have a book here that is dated December, 1884, January, April, and then May. Just look at this. What do these represent? [Handing book to the witness.]—A. These are the deliveries.

Q. Deliveries—are they all deliveries, do you mean? Turn to the back of the book and see what that book is called?—A. Sales journal.

Q. Ought deliveries to appear in the sales journal?—A. I do not know why they should not.

Q. You know much better than I do, Mr. McInlay, of course?—A. Those are the goods invoiced out to the parties.

Q. Would not that assist you in making your calculation as to the amount of sales in April?—A. They are mixed up together. There are part of the old contracts here as well. It is very difficult to get them out.

Q. How did you get them out?—A. With Mr. Casebourne's clerk's assistance. Allow me to explain. All the goods they buy are not put into that contract-book at all. They may be odd things that do not appear in the contract-book at all, but simply appear here as goods bought from different parties, so that you have to pick them out. I did not know them myself without the clerk.

Q. I do not know whether that book will have it. [Handing a book to the witness.] Does that book contain, say, the April account—the corresponding account in April, 1885? Does it go far enough back?—A. I believe it does—yes.

Q. Now compare the two accounts. As shown in that book, what is the comparison between the entries in that book for April, 1885, and the entries for April, 1886. Are they cast up?—A. Yes, that is not the point at all; that is the turnover.

Mr. Justice Cave: Yes, that is so.

Mr. Lockwood: They are to that extent both equally affected, I take it, so far as deliveries are concerned.

Mr. Justice Cave: If deliveries in respect of contracts made before this libel appeared, then they were not affected by this libel. He says his business has fallen off. The business would not fall off straight there and then because he continued to deliver some time afterwards in pursuance of contracts made before. You must take it that he says he has there, by excluding from the total deliveries, the deliveries in respect to prior contracts. He then finds what the proportion of sales was actually made during those four months.

Mr. Lockwood: That would be the same with regard to 1885?

Mr. Justice Cave: Yes, he has taken it out in the same way with regard to 1885. It appears to me to be going into a great deal of irrelevant matter. The plaintiff himself says that the loss on his business is about a tenth. All this no doubt brings out, *prima facie*, a great deal more, which no doubt can be explained away, but he has not put it as his loss.

Mr. Waddy: I think your lordship has misunderstood it. The plaintiff says, not that his business has fallen off a tenth, but that his business now is one-tenth of what it was.

Mr. Justice Cave: Then I misunderstood it, certainly. I thought he said it had fallen off a tenth. I have it down:—"My loss is a tenth of my business." I should have taken it nine-tenths.

Mr. Waddy: Yes, my lord.

Mr. Lockwood: My learned friend is raising rather a serious question of figures here.

Mr. Justice Cave: I certainly beg your pardon.

Mr. Lockwood: It does involve a very long and difficult inquiry into the books. I must ask you then, Mr. McInlay, with regard to my question, whether the same principle does not apply to April, 1885, and April, 1886, there would be deliveries on former contracts of both?—A. That is very difficult to answer.

Mr. Justice Cave: Have you taken out the deliveries of former contracts for the first four months of 1885?—A. No.

Mr. Justice Cave: That will not afford any comparison, then.

Mr. Lockwood: If you take it out in one case you must take it out in the other. I will not ask you any more about that. Now, I must ask you about the profit of the business. I must put this to you—Did you get out a profit and loss account for the half years?—A. Yes.

Q. Am I right in saying that the profit and loss account for the half year ending December the 31st was about £1200?—A. Last year?

Q. 1883.—A. I cannot say from memory. The book is here.

Q. December, 1883, may I take it that the profit for the half-year was £1200?—A. Yes.

Q. June, 1884, there was a loss, I think, of about £100?—A. Yes.

Q. Then, December, 1884, there was a profit of £1486?—A. Right.

Q. In 1884 there was a very large loss by a bad debt, reducing the profit there? The profit in June, 1885, comes down to £648?—A. Yes, £648.

Q. And then in December, 1885; I do not want to give the figure, it is a very large loss; I do not want to say anything at all about it. That is all previous to the publication of this. I might hand your lordship a little table showing the figures; but it is on the profit and loss account taken half-yearly. Is your business like everybody else's, worse every day? We are all objects of sympathy. Business is getting worse, is it not Mr. McInlay?—A. I am sorry to say it is.

Q. And we all hope for better times?—A. Yes.

Re-examined by Mr. Waddy: I want to understand clearly with regard to these figures of sales which you have given us. What do you mean first by a sale? The making of the contract, or do you mean supplying and delivery, the invoicing of the goods?—A. The making of the contract is the sale.

Q. So that whenever the goods are supplied, whether supplied immediately or later, the sales in a certain number of months are the contracts for sale that you have made.—A. Yes, certainly.

Mr. Lockwood: He has not any corresponding months in 1885 to compare.

Mr. Waddy: I think you are in error.

Mr. Lockwood: He told me so, and I stopped my cross-examination.

Mr. Waddy: With regard to what you have taken in the year 1886—you have taken the sales, that is, the contracts for four months?—A. Yes.

Q. The figure that you have given us is £3000 odd?—A. Yes, £3000 odd.

Q. Does that include all the contracts that were made—contracts for the sale of goods made in that four months?—A. Exactly.

Q. Does it include any other contracts except such contracts as were actually made in those four months?—A. No.

Q. Now, with regard to 1885, you gave us a figure of £10,000 odd. Does that include all the contracts for sale made during the four months of 1885?—A. Yes.

Q. Does it include any other contracts except those which were actually made during those four months?—A. No.

Mr. Justice Cave: I thought he said it was all that was sent out during those four months; I thought he said it included that.

The witness: It may have included the same as I explained before; all the contracts are not in the contract book. They buy little things which are not put in the contract book.

Mr. Waddy: I am not talking of the turnover; never mind the turnover at all. Has the £10,000 anything to do with the turnover?—A. Nothing whatever.

Q. Is that contracts, and contracts only? Does the £10,000 include the contracts made during that time, and the contracts only?—A. No, it does not.

Q. What else?—A. Other little things which are not in the contract book.

Q. Whether in the contract book or not, were they the contracts for sale, the sales made during those four months? Do you understand me?—A. No, I do not.

Mr. Waddy: I daresay it is my fault. I will try again.

Mr. Lockwood: I do not know how much further my learned friend is entitled to go with regard to this. I got an answer which practically put an end to the necessity for my continuing my cross-examination.

Mr. Waddy: You had better give me an illustration of what you call "some little things?" First, what do the little things amount to together?—A. A few hundreds.

Q. A few hundreds may mean anything. Twenty or thirty?—A. I could not say exactly.

Q. You are so very uncertain? I must say so, I cannot understand what you do really mean. Now I ask you to tell me what you mean by "a few little things?" I understood you to say to me that the comparison you were making was a comparison between contracts for sale. Is it or is it not a comparison between contracts for sale?—A. Of contracts and some of the sales together.

Q. For 1885? Have you put contracts and sales together in your comparison in 1886?—A. Yes.

Q. Have you made some comparison exactly between the two years?—A. Yes, the same.

Q. Then I think I see what it is. You say contracts and sales. Just one moment. In the cases in which you have included a sale as well as a contract, was the contract for the sale and the sale both of them within those four months?—A. Both.

Mr. Justice Cave: In 1885?—A. Yes, my lord, in 1885.

Mr. Waddy: Have you included any deliveries in that account under "Contracts" made before the 1st January, 1885?—A. No, I think not.

Mr. Justice Cave: You said just now you had.

Mr. Waddy: I thought you had not understood it. Have you in the four months of 1886 included any sales made in respect of contracts before those four months of 1886? Do not you understand me? If you do not, say so; and if you do, answer me, please.—A. No, I do not. Will you repeat it, please?

Q. You have given us four months' contracts for 1886 in the figures you have given us of £3000 for that time. Have you included anything in respect of any contracts made before those four months began?—A. No.

Q. In the four months of 1885 you have given us £10,000 for the contracts and sales. Have you in that figure of £10,000 included anything whatever in respect of anything sold by virtue of a contract made before these four months began?—A. No.

Q. Do you see the point now? Are the two comparisons made on exactly the same principle, including exactly the same things?—A. Exactly the same things.

Mr. Lockwood: I am sorry to have to do it; but I must ask some questions in regard to that,

Mr. Justice Cave: Go on, Mr. Lockwood.

Further cross-examined by Mr. Lockwood:

Q. You are aware that you have given a precisely opposite answer to the one you gave just now, to me, in cross-examination?—A. I must have misunderstood you.

Q. Then I must begin again. You make up £10,000 for the first four months of 1885. Are you prepared to pledge your word that in that £10,000 there are no items except those which represent sales actually made in that period?—A. Yes, that is so.

Q. Now produce the book that shows that—both the sales and the deliveries for 1885—the first four months. Did you make out the account yourself?—A. With the assistance of Mr. Casebourne's clerk this morning.

Q. I would much rather you showed us in the books where you got it from.

Mr. Justice Cave: He says, as I understand it, the books show them together.

Mr. Lockwood: That is just what I want to see, my lord.

Q. The books show them all together, do they not?—A. They do not show them all together, I will show you them separately.

Mr. Justice Cave: They show both.

Mr. Lockwood: Have you the book?—A. Yes.

Q. Would you permit me to come to you for a moment, and then perhaps you can make it clear. I want you to show me the book which contains the entries which make up the £10,000?—A. The first one is here. [The witness pointed them out in the book.]

Q. It would seem, with regard to 1885, that the sum of £10,000 is principally made up by three contracts; one of the 5th of February, one of the 4th March, and another of the 4th of March. Those are three large contracts. In that book you find no large contract such as that?—A. Not in 1886.

Q. Just show me where you get the remainder there?

Mr. Waddy: Could you show me that?

Mr. Lockwood: Yes. Then would your lordship take that these three contracts seem to make up the larger portion of what is said to have been sold in these four months?

Mr. Justice Cave: Yes.

Mr. Lockwood: On two dates—two on the 4th March and one on the 5th February, I think it is. Then I find that the last contract for sale in the book is the 5th December, 1885. Is that so?—A. That is so.

Q. So that you have no evidence of a contract of sale for a month before—will you kindly give me the date of publication?

Mr. Justice Cave: It is the 8th of January.

The Witness: Not that I know of.

Mr. Lockwood: There is no contract of sale between the 13th of November, 1885, and the 5th of December?—A. I cannot see the book.

Mr. Lockwood: My learned friend can see the book.

Mr. Waddy: I have no doubt that that is so with regard to that book.

Mr. Lockwood: If you please I want you to show me where you get the remaining sales from for the first four months in 1885.—A. They are taken out of here.

Q. What book is that?—A. The invoice copy book.

Q. That is an invoice book of deliveries?—A. Yes; but not deliveries belonging to former contracts.

Q. Deliveries of those which you have given before?—A. No.

Q. Of what then?—A. Other things, not in that book at all.

Q. There would be some book I suppose. The first entry would not be the invoice of delivery. There would be the entry of the order. You would not expect in a business to find the first record of the transaction was the press copy of the invoice sent?—A. I have not got the order book.

Q. What particulars are there in that to show the date of the order. Is it on?—A. Yes.

Q. It will refer to some book, will it not?—A. Yes.

Q. Where is that book?—A. I do not know; I have not seen it.

Q. Do you really mean as an accountant to say that in making out this you have been guided, not by the original entry in the book, but by the press copy letter book?—A. That is all that is before me.

Q. Where did you make out the £3000 from?—A. From this book.

Q. Then the book you handed to me relating to April, 1885, is not the book that has guided you?—A. Not altogether.

Q. Has it at all?—A. Of course it has with regard to the £7000.

Q. Show me in that book where it has guided you—you mean the £6000—just show me.—A. Where is the contract book?

Q. It is the sales book—we know all about that—I want the sales book that you had just now. I think it is the top book of those that you have there. Have you been guided by that at all?—A. No, not at all.

Q. I thought you said just now that you had been?—A. I was mistaken. I thought it was the contract book that was lying here.

Q. Will you open that book—have you been through the account of April, 1885, in that?—A. Yes, I have it here.

Q. Have you the ledger here?—A. Yes.

Q. Just let me have the ledger for this period. [It was handed to the learned counsel.] This covers all the periods?—A. 1883 I think it begins.

Q. Where is the index?—A. You will find it in the front of the book.

Q. Yes, it covers the whole ground—am I right in saying that in that book the whole of the entries in respect of April amount to £7237?—A. Quite right.

Q. Now turn to the month of April, 1886; and with regard to the whole trading does it amount there to £6353? A. Yes.

Q. Taking the whole trading, including the deliveries in both, comparing the whole trading; the deliveries under former contracts in both cases; I must compare £7237 with £6353?—A. Yes.

Q. Does £904, which is in that book, represent the whole trading in March, 1885?—A. £904.

Q. Is February £2172?—A. Quite right.

Q. Is January £740?—A. £740.

Q. Do those four items represent, as given in that book, the whole trading, either buying or delivering, for the first four months of 1885?—A. It only represents delivering.

Q. Do just think—do you mean to say that in that book it only represents the deliveries for 1886? I do not understand you to say it included the sales also for 1886. You have not changed the mode of book-keeping between 1885 and 1886, have you? That is what I understood you to tell me. In 1886 does the book that you have there show all the transactions, delivering and selling?—A. It shows deliveries.

Q. And the sales too?—A. Not the sales.

Q. What is the book called? Turn to the back of the book and look at it.—A. "Sales Book." That has nothing to do with it.

Q. Did not you tell me, Mr. McInlay, half an hour ago that the book did include both the sales and deliveries, and I asked you if you had taken them out, and I understood you to say that you had.—A. I have explained before that the sales are the sales made.

Q. Do not any sales appear in that book? Do you mean to say now that in that book which is called "Sales Book" there are no sales?—A. Suppose we sell one thousand tons, it does not appear in this book except as a delivery, not as a sale. When it is delivered it will appear here. (Pointing.)

Q. As a delivery under that contract made in 1886? You can tell that. Cannot you tell the date of the contract?—A. It is impossible.

Q. It is impossible, is it?—A. It is impossible for me to get them out.

Q. Is there any sales ledger?—A. No.

Q. Is there any book which the jury and I can take in our hands and look at and see a record of the sales made—all the sales made in any particular month?—A. There is only the contract book.

Q. But the contract book you say yourself does not contain them; you are short £4000.

Mr. Justice Cave: Do not the deliveries refer to the contracts under which they are made? Do not the entries of the deliveries refer to the contracts?—A. Some of them do.

Mr. Lockwood: Does it not in that book that you have there refer to the contracts under which deliveries are made?—A. Not each invoice.

Mr. Justice Cave: How do they know when they have finished delivering under a particular contract?—A. By the contract book.

Mr. Lockwood: You say there are £4000 worth of contracts made in the first four months of 1885 which are not in the contract book. How do they find out when they have finished delivering that £4000 worth of contracts—by looking to that copy letterbook?—A. I do not know.

Q. As I said before, you, of course, know so very much more than I do about this sort of thing. Do not you see that it is a little hard to come and say this unfortunate newspaper is responsible for all this unless you can show in the books where it is shown to be so. I am sure you appreciate that do not you?—A. Yes.

Q. Then I will go more to general book-keeping. How often are ledgers generally posted up?—A. Monthly generally.

Q. How long is it since these were posted up?—A. I am not aware whether they are written up to date.

Q. Having gone carefully into this business account, cannot you tell me when last the ledgers were posted up?—A. I think I told you before that I only audited the books to the end of December last year.

Q. Surely you can tell from the books as to whether the ledgers have been posted since January, although you only audited them to that date?—A. They are posted up to the end of April.

Q. The ledgers?—A. Yes.

Mr. LOCKWOOD: Is the ledger posted up to the end of April?—Mr. Dodd: No.

Mr. LOCKWOOD: Look at that ledger and tell me whether it is posted up to the end of April?—A. Here it is [pointing to an entry].

Q. In which account?—A. Flensburg's account is the first account I turn to, but I will turn to anyone you like.

Q. Very good. Just turn to any account. Have there been any entries of cash or goods made in the ledgers since the 31st January?—A. Yes.

Q. Can you show me such entries?—A. Yes.

Q. Made in the ledger?—A. Yes.

Q. As you have there entries made in the ledger up to April, 1886, can you not point out to the jury the record of the sales in these first four months of 1886 in the books of the firm not in the press-copy letter-books?—A. Yes, they are here.

Q. Did you get them out from there?—A. The deliveries are here.

Q. Are the sales?—A. The sales are a different thing from the deliveries.

Q. My knowledge just carries me luckily far enough to know that—that there is a distinctive difference between a sale and a delivery. I want to get from you where you got those sales from you make up to £3000?—A. I told you I abstracted them from here.

Q. You got them from that letter book?—A. Yes.

Mr. LOCKWOOD: Very good, if that is your material I will not pursue it.

Re-examined by Mr. WADDY.

Q. With regard to the £6000, that is, we are told, the product chiefly of two or three large accounts?—A. That is so.

Q. These large contracts alone appear to be put in this letter contract book?—A. Yes.

Q. With regard to small matters, were they put in the contract book or kept separate in that account?—A. They were not put in the contract book at all.

Q. Have you gone, with the assistance of Mr. Foster, who knows more about that business, through these small contracts?—A. I have.

Q. If he has lied to you he is wrong?—A. Of course.

Q. If he has given to you a true statement of the case, is that £4000 accounted for by the small contracts which do not appear in the large contract book?—A. Exactly.

Q. Are the contracts I am now speaking of—the small ones—according to what he has told you all made during the four months in question?—A. Yes.

Q. Is that true both of 1885 and 1886?—A. Yes.

The witness withdrew.

Mr. David Foster sworn, examined by Mr. WADDY:

Q. Are you a clerk in the employment of Messrs. Casebourne and Co.?—A. Yes.

Q. How long have you been so?—A. Between eight and nine years.

Q. Are you the clerk that gave Mr. McInlay the information from which he was enabled to make up his account?—A. Yes.

Q. You can tell us the course adopted in the office better than Mr. McInlay? With regard to the large contracts amounting to thousands of pounds, are they entered in that contract book?—A. In that contract book—only iron and steel.

Q. With regard to anything else, either small contracts or contracts not for the sale of iron or steel, is there any book for them?—A. There is simply the order received. Suppose we sell some winches, we simply put that on the file when we get the order, and when the order is delivered we enter it in the book.

Q. In which book?—A. This book: We simply invoice it direct away.

Q. Did you go through the accounts for the first four months of 1885 with Mr. McInlay?—A. Yes.

Q. Do you know, looking at that invoice book, which of those items were ordered, as well as delivered, in those four months?—A. Perhaps, with the exception of one or two small things, the majority of them are dated. You will see the date at the top—the dates of the orders.

Q. If I had known that it would have saved an immense amount of labour. Where is the date of the order? (It was pointed out to the learned counsel.) Oh! I see it now, it is stated here, "ordered January 3rd, 1885."—A. Yes.

Q. Then there is not in reality any difficulty in getting at it. "Ordered January 9th, 1885;" "ordered 15th December, 1884;" "ordered 11th December, 1884;" "ordered 30th December, 1884." Under these circumstances, with this invoice book before you, is there any difficulty whatever in finding out the smaller contracts in addition to those in that book for the sales in those four months?—A. None.

Q. Did you go through that book with Mr. McInlay? Show exactly what you have shown me to the jury, if you please at once.

Mr. Justice CAVE: If Mr. McInlay had been left behind, and this witness had been brought, I think we should have done much better.

Mr. WADDY: I cannot help saying, my lord, I think that that is so.

Mr. LOCKWOOD: We must not come to that conclusion too quickly, I think.

Mr. WADDY: You said it was so in most cases?—A. Yes.

Q. There appear to be exceptions?—A. Yes perhaps in the case where you probably find a lot of invoices where the date of the order is not on; in that case it would be in the contract book—it is iron.

Q. I observe one there of Flensburg?—A. The date of the order would not be there, but you will find the entry of its delivery to correspond with that in the contract book. I should like to point that out if I could have the contract book to show you what I mean.

Q. February 5th. Is the contract sold to Flensburg? Then the date of the delivery is February 27th?—A. Yes, and will find the cash items.

Q. So between this book and that you arrive at it?—A. Yes.

Q. Practically everyone is settled?—A. Yes.

Q. I should like you just to show it to the jury, because there has been some confusion about, and I think it had better be cleared up. Take one of those contracts at the beginning of 1885, and show how the deliveries take place now. [The witness explained to the jury.] I see there is one there to Flensburg which we were complaining about yesterday?—A. February.

Q. That is it. I will just take this in my hand. This is dated in the first existence of the contract, "February 5th, 1885"?—A. Yes.

Q. Then lower down, when that delivery takes place, there is the date, I suppose, of the invoice?—A. Yes.

Q. So that you get both those—the date of the contract and the date of the delivery?—A. Yes.

Q. Here is another, "Flensburg, February 5th." The date of the order appears to be the 27th. There are three separate invoices.—A. It is when it was delivered.

Q. It does not follow that because there are three separate invoices they are three different sorts of iron?—A. Three separate invoices, all the same iron.

Q. Here is another "May;" that is later still, and I will take it as an illustration. "Sold to Shaftsberg." The date of the order is May 9th, and the dates of the delivery are May 29th, June 8th, June 20th, June 24th, July 29th.—A. Exactly.

Q. From that and similar entries, is there any difficulty in finding out the figures given by Mr. McInlay?—A. None.

Q. Did you assist him yesterday and this morning in finding out the amounts mentioned by my learned friend yesterday?—A. Yes.

Q. Did you give him (I put it as a matter of form to you) accurate information to enable him to make up these accounts?—A. Yes.

Q. Did you follow him in the figures he has arrived at?—A. Yes.

Q. Are these figures which he has given accurate?—A. Yes.

Cross-examined by Mr. LOCKWOOD.

Q. I understand that this book is not only a copy letter book, but also a record, and the only record which you keep of your contracts excepting your contract book?—A. Exactly. The only other record is, as I have said, that we have to place the orders as we receive them on a file. When they are delivered we simply take them off and file them again in another book.

Q. You have shown us in three contracts, according to the figures of Mr. McInlay, £6000 worth of contracts in the contract book. Do you really mean to say that of £4000 worth of contracts you kept in your business no record except the copy of the invoice and the press copy letter book?—A. Yes; it is quite easy to do that.

Q. Well, I think it is. It seems to me the most simple way of doing it that I have heard of in the whole course of my life—book-keeping made easy.—A. Allow me to explain. There is probably one item which may come to £400 or £500, and yet be only one article.

Q. I do not follow the weight of that observation. I thought if there had been an item of £400, that probably would have found its way into the ordinary books?—A. Not until it is invoiced.

Q. What is the book?—A. The sales journal.

Q. What does that contain?—A. It contains the items from that book copied into here, and from here into that ledger (pointing).

Q. Anything else?—A. Nothing. All the details are in that book.

Q. It is merely a copy of the letter book?—A. Really it is a copy of that.

Q. Does it contain anything but that?—A. It contains nothing but that.

Q. Nothing but deliveries?—A. Nothing but deliveries.

Q. No sales at all?—A. No sales at all.

Q. It is an unfortunate title you have chosen for the book. [To a juror] What is the name, sir, on that book?

A Juror: "Sales Journal, No. 3."

Mr. LOCKWOOD: Is it a sales journal?—A. It is a record of the deliveries; the stuff actually invoiced.

Q. It is your invoice journal?—A. Yes; probably that would have been a better way to describe it.

Q. Sold journal—sold and delivered.—A. No; nothing but what was delivered.

Mr. LOCKWOOD: That is all I have to ask you.

Re-examined by Mr. WADDY.

Q. I suppose that any bookkeeper looking at the inside of that book instead of at the outside could see very readily what it is?

Mr. Justice CAVE: "What's in a name?"

Mr. Thomas Ray sworn; examined by Mr. ROBSON.

Q. You are a forge master living at Sunderland?—A. I am.

Q. You have had business dealings with Casebourne and Co. for five or six years?—A. Yes.

Q. Did you see that paragraph in THE ENGINEER of the 8th of January this year relating to them?—A. I did.

Q. Had you before you saw the paragraph heard any rumour that they were likely to fail, or were in financial difficulties?—A. No, I had not.

Q. Had you before you saw that paragraph been accustomed to give them credit in your transactions with them?—A. Yes, I trusted them to the 10th of the month after delivery.

Q. Did you after seeing that paragraph continue to give them the same credit?—A. I demanded cash on delivery, after that as regards contracts to be made.

Q. Did you do that in consequence of seeing that paragraph?—A. Yes.

Q. THE ENGINEER, I believe, is a leading paper in the business.—A. Yes.

Q. That is your letter demanding cash, I believe (handing the letter to the witness).—A. Yes.

Cross-examined by Mr. LOCKWOOD: Did you see the correction in THE ENGINEER, Mr. Ray?—A. No.

Mr. LOCKWOOD: I do not know whether your lordship has observed the way in which it is put in—the correction.

Mr. Justice CAVE: Yes, I saw it.

Mr. LOCKWOOD: I should like to call your attention to it; but perhaps it would be better later. It was inserted in a prominent position.

Q. Do you take the paper in?—A. I do not now. I used to at one time.

Q. You did not see that?—A. I did not.

Mr. Justice CAVE: You do not see it regularly?—A. I do not see it regularly, my lord.

Mr. LOCKWOOD: I suppose you heard of the correction?—A. Well, I may say I have. Yes.

Q. When did you hear of it?—A. Well, I have not kept a record.

Q. You say you saw it in the paper; or did you hear of it?—A. I heard of it in the paper—the correction.

Q. The original statement?—A. I saw that and read it.

Q. How long after that did you hear of the correction?—A. I cannot really say at this moment.

Q. A week or two?—A. I will say it was within a month.

Q. You had heard of it probably before you wrote your letter of the 8th of February?—A. Yes, probably I had.

Q. You had heard THE ENGINEER had stated that they were misinformed?—A. Yes.

Q. This is your letter of the 8th of February, which I will read, as my learned friend has produced it:—

The Pallion Forge, Sunderland.

Dear Sirs,—My quotations for the 85 sets of forgings are as follows:—Screw frame, 24s. per cwt.; rudder ditto, 24s. per cwt.; stem car, 16s. per cwt.; terms—cash.

Yours truly,
THOMAS RAY.

You got an answer, did you not, dated the 10th of February:—

Dear Sir,—We are in receipt of yours of the 8th, and accept your price for the forgings, provided you will go on with them at once and give us delivery this month. We agree to your terms, viz., cash, but, of course, the usual discount of 2½ per cent. and 2½ per cent. commission.

There is no allusion whatever to this being a new mode of doing business by you?—A. There is no allusion to it. I knew of the previous report.

Q. What do you mean by the previous report?—A. I knew of the paragraph in THE ENGINEER.

Q. You knew before you wrote this letter of its correction?—A. Presumably so. Well, as a commercial man I had an idea that these things do not do any good.

Q. It was not that you believed the report, but you thought probably it might have injured Casebournes?—A. Yes.

Q. Had you heard other statements about Messrs. Casebournes?—A. I cannot say that I had at that time. I have heard since.

Q. Had you heard from other sources before you wrote your letter?—A. No.

Q. Are you sure of that; just think—about a ship being stopped?—A. No. I had not heard from other sources.

Q. Do you go on 'Change at Middlesbrough?—A. I do not. I am rather a home bird.

Q. Had you heard about Mr. Gladstone going out to Genoa?—A. No.

Re-examined by Mr. WADDY.

Q. The correction does not appear to have entirely restored your confidence?

Mr. LOCKWOOD: I suggest that that is not a proper way to put the question.

Mr. WADDY: Very well; I have no questions to ask.

Mr. William James Hardy sworn. Examined by Mr. WADDY.

Q. You are in the firm of Messrs. Caspar and Co., coal exporters, West Hartlepool?—A. I am manager for that firm.

Q. Previously to this appearing in THE ENGINEER had your firm been in the habit of doing business with Casebourne and Co.?—A. Yes.

Q. Was Mr. Casebourne's credit good with your firm?—A. Yes.

Q. In the beginning of January did you either see or hear of this statement in THE ENGINEER that they had failed?—A. I saw it in THE ENGINEER.

Q. Did you report it to the principal of your firm?—A. Yes, immediately I saw it.

Q. Did your firm, you and your principal in consultation, determine on doing anything in consequence of seeing that?—A. We determined not to sell to them except we got cash on delivery.

Q. To stop their credit?—A. In fact it meant to cut the connection.

Q. Did you write them in consequence that letter [handing a letter to the witness]?—A. Yes, I wrote this letter.

Q. "The 30th of January, from E. A. Caspar and Co.," written by this gentleman to my clients—

Dear Sirs,—We are in receipt of your yesterday's favour, and will be glad to supply you with the coals required as follows:—Haswell Pens, 6s. 3d. net; best Eldon steam, 7s. 3d.—2½, f.o.b. steamer in Middlesbrough-on-Tees, payment cash against invoice. It is with great regret that we are compelled to alter our usual terms with such an old connection as yours, but in the face of the reports circulating this last week or two, we consider we would be acting unfairly towards ourselves did we stipulate for any other than prompt cash payments in all future transactions. If you agree to these terms, we will be glad to receive the steamer's name as early as possible.

Was there any reason for that alteration which you imposed except what you had heard about them in THE ENGINEER?—A. Nothing but that.

Q. Is THE ENGINEER a paper that you take in generally?—A. No, we do not take it in, but I saw it in the news-room.

Q. I don't know whether you ever saw the correction?—A. No, never saw the correction. I did not see THE ENGINEER that week, that was it.

Cross-examined by Mr. LOCKWOOD.

Q. You continued to do business with the firm I believe?—A. Yes.

Q. I see in the letter you used the word "reports." Had you heard general reports circulated about them in connection with the failing of an Italian firm?—A. I learned first about the failure of the Italian firm somewhere after seeing the report in THE ENGINEER. I made inquiries then to ascertain the cause of the failure.

Q. Had you heard that there had been a failure of a firm in Italy—at Genoa?—A. Yes, I heard that.

Q. When you wrote your letter of the 30th January, you knew what the actual facts were; you knew that Messrs. Casebournes had not failed?—A. Yes, I knew that, but then that report coming on the top of it, I did not know what might happen, and I thought it was best to use caution in the transactions.

Q. Did you know that they had made a large bad debt?—A. On the 13th of January.

Q. Yes?—A. I knew that then.

Q. That was so?—A. That was a fact.

Q. Did that influence you?—A. The fact of their making a bad debt would not have influenced us at all.

Q. Were you aware of the letter which my learned friend read, calling together the creditors?—A. No.

Q. It was a private letter which my learned friend read calling together the principal creditors?—A. I was not aware of that.

Mr. WADDY: It was only sent to one firm?

Mr. LOCKWOOD: You mentioned three, but I thought it was sent to them—but nothing turns upon it.

Mr. LOCKWOOD: I do not quite understand your account with them. On the credit side there is "Cash, cash, cash," then "Goods, goods, goods." What are those items referred to?—A. I cannot say anything about Messrs. Casebournes' books.

Q. I am looking at your accounts with Messrs. Casebournes'. Can you explain that?—A. I might if I could see the book.

Q. I will hand you the book [it was handed to the witness]. What I mean is this. Take July.—A. If you will give me the steamer's name I should be better able to trace it.

Q. I am afraid that Messrs. Casebournes' books do not run to that length; they do not give the name of the steamer, and I am only too glad to get the date of the order. Perhaps you would just look at that account, Mr. Hardy, in the credit column—what are these items here. "Cash, £7, £3?"—A. That is a small account alone, after bank hours; I used to do that several times.

Q. To the firm—you have not ceased, have you, to make these extensive monetary advances?—A. It is customary after banking hours to do this.

Q. It is very nice and proper—you have not ceased to do that,

I hope; Messrs. Caspar and Co. would still advance £3?—A. You must understand that these advances are not exactly any question of loss, but a mere matter of advances; they are paid again in the morning as soon as the bank is opened.

Q. I am suggesting that it was not in the nature of a loan, but it was in the nature of a convenience?—A. With reference to the £7 and the £3 on the credit side.

Q. Would you have put it hard "Cash, cash?" You certainly have not lost confidence in that way, because I see a large entry on April 12th—as large in amount of cash as £40?—A. That is April. When our confidence was so considerably shaken was in January and February. Our confidence has been in a measure restored now.

Q. Let us see about that. On the 25th of February those goods you delivered and obtained payment for?—A. Yes.

Mr. LOCKWOOD: That is all I ask you.

Re-examined by Mr. WADDY.

Q. You did not see the correction, but after that letter of the 30th of January you had an interview with Messrs. Casebournes?—A. Yes.

Q. And the series of the cash and change that you advanced to each other at nights after the bank was closed were continued. I will not go into that.

Mr. WADDY: There is one question as to which my learned friend made a statement, and a perfectly accurate one, with regard to the profit and loss account of the last two or three half-years. In December, 1885, my learned friend stated that there had been a very considerable loss instead of a profit. I should like to ask Mr. Foster or Mr. Casebourne one question with regard to that.

Mr. Justice CAVE: Very well, you can ask.

Mr. G. E. Casebourne recalled. Further examined by Mr. WADDY.

Q. The loss, I believe, in December, 1885, was this very loss of Samango?—A. Yes.

Mr. LOCKWOOD: I think I said that; at any rate, I intended to say so.

Mr. WADDY: And amounted to £7935; the amount of the debt, £7935 at one blow?

Mr. LOCKWOOD: That was not all lost; they got a dividend.

Mr. WADDY: The dividend does not come into that year. The losses of that year would be reckoned the whole £7935.

Mr. LOCKWOOD: I shall accept that as being so. The whole of the £7935 is brought in as loss in that half-year.

Mr. Justice CAVE: No, I suppose it was estimated at what it would fetch.

Mr. WADDY: My learned friend says £5000, and I will take it so, to save time. Now I will take your lordship's view as to this in the notice. In the notice of the evidence they intended to give here they said that they have given us notice that they proposed to produce evidence as to the report on 'Change. I have witnesses here who were on 'Change to say there was nothing of the kind; people who were there. I don't know whether your lordship thinks that I should be justified in calling that evidence until evidence is given the other way.

Mr. Justice CAVE: I think it would be more convenient to wait until we hear what is said on the other side.

Mr. WADDY: My lord, that is the case.

Mr. LOCKWOOD: May it please your lordship, gentlemen of the jury, I really feel that you are owed some apology, both from my learned friend and myself, for having taken up a good deal of your time with what has certainly not been a mere amusing inquiry, except in so far as one can extract humour from the mode in which the books of Messrs. Casebourne have been kept. I appear, gentlemen, with my learned friend Mr. Dodd, on behalf of this newspaper, and we are standing up to be shot at. There is no doubt about that. My learned friend has opened his case with a great amount of skill, if I might so say, and a certain amount of ingenuity, because he has endeavoured in opening this case to represent to you the conduct of this newspaper, THE ENGINEER, in a somewhat unfavourable light after the time that they made this very unfortunate mistake. I hope, gentlemen, in the few observations which I shall have to address to you on that part of the case, to show you that really, in accordance with the common spirit of fairness, my learned friend is not entitled to ask you to view the conduct of this newspaper in that light. But, gentlemen, before I come to the justification, and to a certain extent the refutation, of the observations which my learned friend has been instructed to make on that part of the case, I may say something to you with regard to the publication of this undoubted libel. Mistakes will happen in the best regulated newspapers. But you will judge the newspaper, I hope, sufficiently leniently with regard to the mistake and judge them by their subsequent conduct after the mistake has been made; but if you find a newspaper going into Court after it has made a mistake, and endeavouring to justify that mistake, and failing to justify that mistake, then to my mind no language can be too strong in which the conduct of such a paper should be condemned. But if you find a paper coming into Court after the mistake has been made, endeavouring in every honest way that suggests itself to them to make all the reparation in their power, and to express the most perfect regret, then, gentlemen, I venture to think you will draw a very strong line of demarcation in the estimate which you form of the conduct of the newspaper, either in the one case or in the other. Gentlemen, let me say, on behalf of the paper which I represent, that all connected with that paper most deeply and sincerely regret the announcement, the pain and the injury which has been caused to Messrs. Casebourne by the publication of that article; and so soon as that article had been published, they did this—they sent to Messrs. Casebourne a letter setting forth that which they desired to state in their paper on behalf of the people of whom they had said that which was not true. May I appeal to you for a moment to ask you this. Do you think it was quite fair of my learned friend yesterday to complain of the spirit of language of that correction when you remember that before it was published it was sent to these gentlemen for approval and correction, and they refused to do either one or the other. If they read it, as I assume they did, they must have seen, if it is true, that this correction would be likely to injure them. Then, gentlemen, I say surely, in all common fairness, they should have written back and said so—"This correction you propose to publish does not meet the case at all." I suppose they wanted a correction of some kind, and if they do not agree to the one suggested, why did they not send another? No such suggestion is made, and we are left simply without any guidance in this matter. I do not want to introduce anything appertaining to the nature of strong observations in this case, because the whole thing lies in a nutshell. The mistake was made, which was deeply regretted, and I only want to show you that after this unfortunate mistake was made the paper did all in their power to correct it. It is not, says my learned friend, that the newspaper has been actuated in this matter by any malice, not for a single moment, and so directly their attention is called to it, the original libel complained of being in this position, and it is not altogether immaterial that you should notice the relative positions in which the two things appear. You see, gentlemen, that is how it appears. It is lined round. There is nothing to call general public attention to it. Now, then, I want you to compare, please, the mode of the correction, and to ask yourselves which is most likely to catch the eye of the reader, to show the *bona fides* with which this is done. It is to be in the most prominent part of the newspaper, under the word "Correction." It is printed in type which would be likely to catch the eye of any reader. They did all they could to submit that correction to the firm for their approval, and it was returned with some message which was not over polite—"you must do what you like, we cannot help you with any suggestions." I do not see for the life of me what else they could do. That was done in the earnest and honest hope that it would catch the eye of every person who had read the paragraph containing the original mistake. Now, having called your attention to the type, let me for a moment call your attention to the wording of this correction of which my learned friend complains. "We regret very much the statement made in the letter of our North of England correspondent which appeared in our last impression, to the effect that Messrs. G. E. Casebourne and Co., of West Hartlepool, had failed. It appears that a large customer of that firm had stopped payment, and we are informed that Messrs. Casebourne and Co., beyond being sufferers by the loss, are not affected in their business." Says my learned friend, this is the way in which newspapers always proceed to justify that which they have said. Really I think that is a little hard, and is a very strong construction to put on it. It is for you to say, but in reading this I do not recognise any attempt at shirking responsibility; but, on the contrary, they state that which had occurred beyond a doubt. But they say, "Messrs. Casebourne, beyond being sufferers, are not affected in their business, and that the steamship to which reference was made was not stopped by a creditor, but by Messrs. Casebourne themselves"—showing how utterly wrong they had been in the statement that they had made. They had said that the steamer was stopped as against Messrs. Casebourne. The fact was that Messrs. Casebourne themselves stopped the steamer. I cannot for the life of me see how it is to be urged against this newspaper that they went out of their way in this correction to show how absolutely wrong they had been, and to show how diametrically opposed the real facts were. They stated that, not for the purpose of vindicating themselves, but for the purposes, as honest men and as gentlemen connected with this paper, by making the fullest and amplest apology that it was within their power to do. Beyond all that, they submit themselves to the person who has been injured; they crave from him any correction; they crave from him advice and suggestion, but they get neither one nor the other. Therefore there is no course open to them but simply to publish that which they sent. So much for the conduct of this paper, and I think I am justified in making the remarks which I have. The mistake is made, for which no doubt we are responsible, and for which, as I said just now, this paper is standing up to be shot at; but I ask you when you come to judge what you are going to do with them, to take the view which I have represented their conduct in, and not the view in which it has been represented to you by Mr. Waddy in opening this case yesterday. As he said, he absolved them from malice; certainly he involved them in mischief. He says, your conduct is not malicious, but it is mischievous in what you have done. I hope I have met that charge of mischief, and shown you that, so far as we are concerned, this newspaper has determined to do all in their power to rectify the wrong which has been done. Now, gentlemen, I will tell you how that is done. This letter is a private letter, which I agree perfectly with my learned friend had not a bit of business in this paper. This letter, which was written to one creditor, had nothing to do with it; but unfortunately not to them, but to somebody else this matter leaked out, and was the talk on the 'Change at Middlesbrough, and unfortunately it came to the ears of a gentleman named Head, who acted as the correspondent of the paper in the North of England. He, acting perfectly *bonâ fide* in the matter, wrote this letter which has unfortunately rendered this paper responsible. We are responsible for what our correspondent sent off and that which we published. I am not endeavouring to shirk any responsibility which you in your good judgment may see fit to put on the defendant; but it was done in all good faith, and influenced by what he had heard on 'Change, Mr. Head wrote that letter. In all good faith he accepted it without any malice, and after the communications that were made to Head, and the source of the information he had, it will be for you to say whether there was negligence in what they did. There it was published at any rate. That is the case I am going to submit to you so far as the evidence is concerned. I now come to deal with the case represented by my learned friend with regard to the position of Messrs. Casebourne, and the effect which it has had upon them. Let me be very careful with regard to what I say; not for a single moment to say anything that is detrimental to the credit of Messrs. Casebourne, because I have no information which entitles me to make any observation of that sort, and I am particularly anxious in the conduct of this inquiry that I may do nothing whatever to increase or further any injury these gentlemen may have suffered. It appears they had had a very large and substantial loss, which fortunately for themselves they were able to meet, and, I am sure that I say it conscientiously, in times like these I heartily congratulate them on having been able to meet with the blow such as they had sustained, and to continue their business. Do remember, gentlemen, that that great loss has not anything to do with this. That is entirely independent of this case, and in no way influenced by the defendants. It was the occasion, no doubt, of this rumour. It was the ground on which this rumour began to circulate, and I am glad indeed to think that Messrs. Casebourne were able to meet their loss and honourably to conduct their business from the time of the loss as they have done up to now, and I hope, and I am sure on the part of the defendants I may say they hope, they may go on successfully for many years to come. Now, gentlemen, let us for a moment consider this claim of damage. I have put before my lord, and at some time, perhaps, you may have your further attention brought to it, a document which shows what the trading of Casebourne is, seeing that really they, like others, have been affected by the terribly bad times from which, I venture to say, we were all suffering. We had the balances for the half-years beginning with the profit on £1200, then next a loss, then £1400 profit, then a loss of £648 for the half-year ending June, 1885. It is evident the business was very much affected by the bad times in June, 1885, and if one may judge by the book which contains the deliveries, which is called the sales' book, you find on comparing April, 1885, with April, 1886—that includes all the deliveries—you will find that April, 1886, compared with April, 1885, is £12,000 in 1886 and £11,000 in 1885. That is what my learned friend has spoken of as the turnover, which he says is not a fair criterion. It includes, as I understand, both; it includes deliveries on contracts made within the period, and it includes deliveries on contracts made outside the period. It appears to me to be a book which is the most reliable book, as denoting what the general trade of the firm has been, that I have been able to put my hands upon. But the clerk in his evidence says that the real book which we ought to look at is this press-copy letter book. Again, I do not want to make any comment on the book-keeping of this firm, but it appeared to be a very remarkable thing. An endeavour has been made to show that beyond the contracts which are included in the contract book, all the contracts, representing about £4000, are contained in this press-copy letter book.

Mr. WADDY: It is not a letter book; it is an invoice book.

Mr. LOCKWOOD: Well, "copy invoice book" I will call it. Now, let us pause here. That £10,000, which is given you as representing sales in the first four months of 1885, contains and is principally made up of three large contracts, which the firm fortunately were lucky enough to make, two on the 5th February and one on the 24th March. That is the backbone of that £10,000. Gentlemen, are you going to assume that if this had not appeared in THE ENGINEER, in February or March, 1886, Casebourne and Co. would have made three large contracts like that or anything like them? Of course, my lord will direct you as to the measure of damages; but it appears to me you would be assuming a great deal too much against the defendants to assume that. Because what do we see in this contract-book? We see that from the 5th December, for a whole month before this was published in the newspaper, there is not a contract entered similar in terms or extent, or worthy of a place in that contract-book which contains these three; so that it would not be right that you should assume, for the purpose of assessing damages, any such state of things as that. Then my learned friend endeavours to prove his special damage, and calls Mr. Hardy from the firm of Caspar, and he calls Mr. Ray. With regard to Mr. Ray, I do not see how any damage whatever can be said to be sustained in respect of Mr. Ray. He says, fairly enough, I read the article; I read the correction—I had read the correction before I wrote my letter, "Terms, cash."

A Juror: He had heard of it.

Mr. LOCKWOOD: It is not material whether he had read it, as long as it had been brought to his knowledge. What I want to do is to show you that before he wrote his letter the fact of the correction had been brought to his knowledge, and that he says is so. Then why did he write? He says:—"Because I did not think that the publication of a thing of that kind would do any good to the firm," not because he himself, when he wrote, had any doubt about the stability of the firm, but because he thought that this might injure them. As far as that is concerned, I turn to the ledger, and I find—goods on the 31st March, £103 16s. 9d. Then I find on the cash side there is no cash payment until the 3rd of April. Then there is a payment of £25. This is in Ray's account. "Mr. Thomas Ray, of Sunderland," &c. [Reading further items of the account.] Then on the 30th of April I find a delivery of £162, in respect of which a payment is made of £110, so I actually find that as to the first delivery of goods, on the 31st January (£88 10s. 5d.) that is met by a cash payment. There is a cheque for £68 5s. 10d., and so on. Looking at this account, I really cannot see that Thomas Ray, under whatever impression he may have been when he wrote that letter, has acted in any way to the detriment of this firm in consequence of what his knowledge was; that is the fair way of looking at it. Not for a gentleman to come and say:—"I read that, and I thought this;" Mr. Thomas Ray's state of mind may differ from day to day, but this record does not; and I shall ask you, before you visit these special commercial damages upon this newspaper on anything like the basis on which my friend is going, to have regard to the transactions in these books, the character, extent, and nature of them, and then say:—Are those commercial transactions in respect of which we ought to award anything like heavy substantial damages on a commercial basis? Take also the case of Caspar. There the transactions appear to be very small—not great commercial transactions which have been affected by the publication of this newspaper. I suppose Mr. Caspar will lend his £3 that may be required when the bank is closed, as before, and the £7 2s.; but these are not matters upon which to put forward a claim for heavy damages in the way my friend has put it forward. Please do not assess the damages on that basis at all. Award such damages as you think fairly consistent; measure them by your own good sense, and good judgment. But, gentlemen, I ask you first of all not to allow my friend to base his claim on the commercial basis upon which he has endeavoured to put it; and secondly, I think I am entitled to say this, that surely there has been nothing in the conduct of this paper since this unfortunate mistake was made which entitles one hard or harsh word to be said with regard to it; but having made a mistake, my clients have to the best of their power endeavoured to make honest reparation for any damage they may have caused.

The Foreman of the Jury: Will you permit the Jury to see the ledger?

Mr. WADDY: Your lordship will remember that the particular figures to which my friend has been drawing attention in his observations just now were not mentioned by my friend to either Mr. Casebourne or his clerk, on the one hand, or to Ray on the other.

Mr. Justice CAVE: No. If you want to give any explanation about them you shall.

Mr. WADDY: If your lordship pleases. Perhaps it would be almost better to do it now whilst the Jury are upon it.

Mr. Justice CAVE: Yes, perhaps it would.

Mr. G. E. Casebourne re-called; further examined by Mr. WADDY.

Q. It is suggested by my friend, upon looking at the figures to which the attention of the Jury is now given, that credit has been given after this time by Ray to you. Just explain that?—A. The reason of that is, the dates of the invoices are put on them, but the dates of delivery were altered on account of the steamer not being in at the time at which the stuff was invoiced. Therefore we paid for the stuff as soon as it was delivered.

Q. As a matter of fact, you never got a day's credit?—A. No.

Q. I think, if I observed it rightly, you will find that the last payment comes on the 30th of the month, which is the exact date of the opposite amount?—A. Yes; as soon as the steamers came in with the cargo we paid for them as soon as we got delivery of the stuff.

Mr. Jeremiah Head affirmed; examined by Mr. CYRIL DODD:

Q. You are a partner in the firm of Fox, Head, and Company, of the Newport Rolling Mills, Middlesbrough?—A. I am.

Q. What are they?—A. Manufacturers of iron plates.

Q. And in addition to that are you the regular reporter of the ENGINEER newspaper?—A. I have been for some time.

Q. And were you the reporter who sent up to them this mistaken communication about the failure, which afterwards appeared?—A. I am.

Q. And at the time you sent them up the intelligence did you honestly believe in the truth of it?—A. I did.

Mr. WADDY: I do not think there is anything in this.

Mr. Justice CAVE: There is no harm in allowing the witness to say he believed it.

Mr. DODD: When first did you hear of this supposed matter

of failure of Casebourne and Co.?—A. On Tuesday, I think it was the 5th of January.

Q. Where?—A. On the Middlesbrough Exchange.

Q. From whom?—A. From Mr. Robert Jameson.

Q. Who is Jameson?—A. The secretary of the West Stockton Ironworks.

Q. They also are manufacturers, are they?—A. They are.

Q. Did you, on 'Change, hear it from anybody else at that time?—A. I heard it confirmed.

Q. Who by?—A. Mr. Joseph C. I'Anson.

Q. What is he?—A. He is a partner in the firm of Fry, I'Anson and Co., one of the creditors.

Q. What was it that Jameson told you?—A. He asked me if I had heard about Casebourne and Co. I said, "What about them?" He said that they had come to grief. I asked for further particulars. He said that they had made a large bad debt with a foreign merchant named Samango, which had produced the effect. He said there were other firms in with Casebourne and Co., namely, the West Hartlepool Ironworks, Fry, I'Anson, and Co., and Dorman, Long, and Co. That he had himself seen Mr. I'Anson on 'Change, and he had practically confirmed it.

Q. Did Jameson at that time say anything else about this that is material, do you recollect? Just think for a moment. —A. He said that Mr. Gladstone, of the West Hartlepool Ironworks, and Mr. Robinson, a partner of Casebourne, were then on their way to Genoa to see what they could save from the wreck.

Q. Mr. Gladstone had one time been in some way interested in Casebourne's firm?—A. Mr. Gladstone, I believe, was at that time partner with Mr. Casebourne in another venture.

Mr. WADDY: I think this is wide, what this gentleman believes about the relations of Mr. Casebourne and Mr. Gladstone.—A. I may say I know that Mr. Gladstone was at that moment—

Mr. DODD: The point is that he had gone to Genoa, or was supposed to have gone. Just think for a moment whether there was anything else that you recollect, anything material said about what was supposed to have happened to Mr. Casebourne, said by Jamieson at that time?—A. There was something about a ship; that a ship laden with iron joists at Dorman, Long, and Co.'s works had been stopped by Messrs. Dorman, Long, and Co.

Q. Except regrets between you, that was in substance all that was said at that time?—A. Yes.

Q. Then you went to Mr. I'Anson, who was on 'Change?—A. I did.

Q. What did you say to him?—A. I said I had heard that Casebourne and Company had gone down, and that he was in.

Q. What did he say?—A. He said he hoped that it would turn out so that there would not be much loss.

Q. But did he say anything in any way to lead you to suppose—

Mr. WADDY: No, no; if you please you must not lead.

Mr. Justice CAVE: What did he say?—A. He said, as I have just told you, that it was so, but that he hoped they would come out without much loss.

Q. Who was the next person from whom you heard anything about this supposed matter?—A. The next person I can remember distinctly was in the Cleveland Club, which adjoins the Exchange, and where we generally go in afterwards to lunch.

Q. That was the same day?—A. The same day, and within an hour of this I lunched at a table where there were several sitting discussing this matter.

Q. Who was the gentleman you knew at the table?—A. Mr. Fife Scott, of the firm of Scott Brothers, of Newcastle.

Q. You say you do not remember distinctly any other person. What do you remember?—A. I remember that Fife Scott was talking a good deal about this.

Q. Do you remember what was said in substance?—A. I remember something was said about another firm having lost a good deal with this man, Samango, as well.

Q. What was said about Casebourne's firm?—A. It was simply said as a matter of general concern. The discussion mainly was about Samango having gone down and let all these people in—Casebourne and Co., and another Hartlepool firm.

Q. Was Mr. Casebourne on 'Change?—A. He was not. I particularly looked out to see if he was.

Q. Was he in the habit of going on 'Change generally?—A. Very often, but not always regularly.

Q. You know Mr. Gladstone?—A. I do.

Q. And you know Mr. Hill?—A. I do.

Q. Tell me when you first heard of anything Mr. Gladstone had said?—A. What Mr. Gladstone said? That was after the action was threatened, not before.

Q. What other information had you beyond what you told us when you sent to the newspaper the information you sent. You have told us of Mr. I'Anson, Mr. Jameson, and the talk at the lunch?—A. Yes, Mr. Fife Scott.

Q. Had you any other information beyond what you have told us when you sent the notice up?—A. There were one or others with whom I discussed it on 'Change, but I do not remember who they were now.

Q. Had they heard the news, or were you telling them the news?—A. No; I think they had heard it.

Cross-examined by Mr. WADDY:

Q. Why did you look to see if Mr. Casebourne was on 'Change? —A. Because I thought if he had been on 'Change it might have been there was no truth in it, and I could have gone to him and asked him.

Q. You would have gone to him and asked him if he had been there?—A. Yes.

Q. How far is his office off from 'Change?—A. It is at Hartlepool, which is eight miles off.

Q. Did you take any steps to endeavour to find him at Hartlepool? You have told us he did not regularly attend 'Change. —A. Not at that time.

Q. Did you at all before you had published this damaging announcement?—A. There was scarcely time.

Q. But you know the world would not have stood still if you had waited for a week?—A. No; that is so.

Q. There could not be such a desperate hurry to announce that a man had failed. Did you take the slightest trouble to ascertain from Casebournes themselves whether there was any truth in it?—A. I did not communicate with Casebournes.

Q. Why not?—A. In the first place, there was so little time.

Q. But was there any absolute necessity to have it in that week?—A. No.

Q. Then, rather than lose a week, you preferred to risk it?—A. I believed it to be unnecessary. I looked upon it as absolutely certain.

Q. Then, at all events, the entire amount of authority you had was that it was rumoured on 'Change?—A. I do not think that is a fair way of putting it.

Q. What more was there?—A. It was distinctly told me as a fact, was confirmed by a person who was one of the creditors.

Q. Well, that is the same thing, is it not? "It was mentioned or stated on 'Change." Is that the outside limit of it?—A. It was undoubtedly stated on 'Change.

Q. Would that be a fair and outside rendering of what had come to you?—A. I do not think it would.

Q. May I ask what more was there than that?—A. It was stated as a positive fact, and confirmed by one of those most likely to know.

Q. I want to know why you use this somewhat formal word, the failure is "announced." Announced in what document, or by what office, or in what way?—A. It was announced by no document, but by the statement of individuals likely to know.

Q. Then do you mean to say that anybody on 'Change had stated it out?—A. They had.

Q. Who?—A. Robert Jameson.

Q. You mean in the conversation with you?—A. Certainly.

Q. Then in future are we to understand, when we read your documents coming from the North, that when you say a thing has been announced, you mean that you heard it in a conversation with a gentleman?—A. I think that was not an unfair inference.

Q. One wants to know the value to be attached to it. Is there any one of those gentlemen, whose names we now hear for the first time, here to-day?—A. Yes.

Q. Who?—A. Robert Jameson.

Q. He was the first person. Is Mr. I'Anson here?—A. He is not.

Q. He is the gentleman upon whom, as I understand, you chiefly relied, because, to use your own words just now, he was the one who confirmed it?—A. He confirmed it. I did not say that I relied upon it chiefly.

Q. When I put to you the difference between the statement of I'Anson, you said it was not only told you, but confirmed by one of the principals?—A. Yes.

Q. Well, he is the gentleman to whom you refer. Now, I put this to you—Is not Mr. I'Anson the only person, according to your account, of whom you made any inquiries, and that would be supposed to know anything of the matter?—A. No, I think that is not the only person.

Q. Tell me anybody else connected with this matter?—A. I have mentioned one other.

Q. Who?—A. Fife Scott.

Q. Fife Scott had nothing to do with it?—A. He knew all about it.

Q. I am sure you know that is not a fair answer to the question. The persons said to be involved in it are Simango—he was at Genoa; Mr. Gladstone, who was on his way to Genoa; Dorman and Long is another, Mr. I'Anson another, and the Casebournes themselves are another. Now I ask you whether there was anybody else at all concerned in this matter, and from whom, therefore, it would be natural and proper for you to inquire?—A. I have told you all I inquired of.

Q. Kindly answer my question?—A. I cannot say more than I have.

Q. Yes, you can. I ask you whether there was anybody else, as far as you knew, that was concerned in the matter, and therefore would be able to give authoritative information?—A. I have already said that was the evidence I went upon.

Q. That is not what I am asking you, and nothing like what I am asking you. I am asking whether there was anybody else you knew of at the time that could have given you any information?—A. I thought I had sufficient.

Q. Will you answer me—was there or was there not? I put a fair question to you; you may answer or not, as you like. Was there or was there not any other human being than those I have mentioned who could really give you authoritative information, according to your belief at the time?—A. There might have been more.

Q. Was there, or was there not?—A. I have no doubt there were.

Q. Who?—A. Dorman, Long, and Co. might.

Q. I have mentioned them. I have mentioned Dorman, Long, and Co.; I have mentioned Mr. Gladstone, I have mentioned Mr. I'Anson—those three, and, of course, these unfortunate gentlemen themselves. Except those four persons, was there anybody else on earth that you at that time believed could give you authoritative information?—A. I dare say there might have been.

Q. Who did you think there was?—A. The only persons I thought accessible at the moment would have been Dorman, Long, and Co.

Q. You did not go to them?—A. I did not; I am not sure that they were on 'Change.

Q. Where was their office?—A. About a mile off.

Q. Do I understand you really that to save yourself the trouble of going for a mile to inquire you would actually put in this statement which might inflict such infinite damage upon persons?—A. I had no doubt whatever at the time I had sufficient evidence that it was correct.

Q. It is for the jury to judge of that, not you nor I. Mr. I'Anson was the only person of whom you could inquire except Casebournes and Dorman-Long. Dorman-Long's is a mile off, and you never go near them. The West Hartlepool Company; how far was their place?—A. Eight miles.

Q. You made no inquiries from them; no inquiries from Casebournes. Mr. I'Anson is the only person from whom you did. Now I ask you, is not Mr. I'Anson here to-day?—A. He is not.

Q. Who is Fife Scott?—A. He is a merchant at Newcastle.

Q. In the same way of business as the Casebournes?—Well, not exactly.

Q. Well, what then, iron merchants?—A. Yes; iron and other things.

Q. Well, that is exactly the description they have given of themselves.—A. Well, he is not quite the same; he does more in pig iron.

Q. But he is an iron merchant. Where?—A. At Newcastle; but I was in the same district.

Q. Should you have had any difficulty in finding out from comparisons the real state of affairs. Were you not yourself a creditor of Casebourne's to a small amount?—A. Yes.

Q. So that you had a perfect right to go and inquire from them the real state of affairs?—A. Oh! I daresay; it is only £10.

Q. I am not saying you were influenced by it; I am not suggesting anything so wicked; I simply mean that as you were a creditor of theirs you would be entitled to say: "I understand you have stopped?"—A. It would not have been worth while.

Q. I am not speaking of the value of the £10; I told you that?—A. But I was.

Q. That is exactly what I was not speaking of. Was it not worth while before you put in that paragraph to take the trouble to make some inquiries from Casebournes themselves?—A. Of course, if I had known then what I know now I would have done so.

Q. You knew precious little. Why did not you take that obvious course of ascertaining the real truth?—A. Because I believed that I had sufficient information. I did not doubt that it was true.

Q. I will ask you this question, because I should like to get the very words, and I am not quite sure that I have got them. What I understand you to say is this. In the first instance, as I understood you, you had heard a report from somebody or other, and then you told us it was Jameson, and then you told us that they were gone down. I think that was your expression?—A. Come to grief.

Q. Gone down were the words you used.

Mr. LOCKWOOD: No, he said they had come to grief.

The witness: It means the same thing.

Mr. WADDY: "I went to I'Anson. I told him I had heard they had gone down; and he was annoyed." Those, I believe, were the words?—A. Yes, something like that.

Q. You say something like it. Kindly tell me—because a good deal may turn upon the words—to what words you will pledge your oath that you did use to I'Anson?—A. What I said before, namely, that I had heard that Casebournes had come down.

Q. That is the third form of words you use?—A. The meaning was failure.

Q. I do not care twopence in the world about the meaning, because that again the jury must judge of. I am asking you what was said in this important conversation. You went to I'Anson's, and I want to know what you you said to them. What did you say to I'Anson's; what were the words you used?—A. That I had heard that Casebourne had "come down" or "gone down," and that he was "in" as one of the creditors. Was it true or not?

Q. What did he say?—A. He admitted it.

Q. What did he say? Do not say, "He admitted it."—A. He said "It is so; but I think we shall come out without much loss."

Q. This is the third account. The first time you gave your account you entirely omitted to say—"He said it was so." The first time you said this—"Mr. I'Anson said he hoped he would come out without much loss." Then you repeated it and said—"He said it was so, and hoped they would come out without much loss."—A. Yes.

Q. Will you undertake to swear he said it was so, or simply that he said he hoped to come out without much loss?.—A. I will undertake to affirm he said it was so.

Q. I beg your pardon—I am sure I did not mean to put that to you offensively—you undertake to affirm what?—A. That he said it was so; but that they hoped to come out without much loss.

Re-examined by Mr. LOCKWOOD:

Q. At any rate, did you honestly believe that what you wrote was all fact?—A. Certainly; or I would not have done it.

Mr. Ralph Jamieson, sworn; examined by Mr. LOCKWOOD:

Mr. LOCKWOOD: I believe you are secretary of the West Stockton Iron Company? A. Yes.

Q. Had you a communication made to you on the 2nd January, 1886, by Mr. John Hill?—A. Yes.

Q. He is the managing partner of the firm?—A. Yes.

Q. Mr. John Hill is here, I believe?—A. Yes.

Q. The statement related to the affairs of Messrs. Casebourne and Co.?—A. Yes.

Q. On the 5th January, 1886—this year—did you see Mr. Head on 'Change?—A. Yes.

Q. Did you repeat to him what you had been told by Mr. Hill?—A. Yes.

Q. Tell me now what conversation you had with Mr. Head? —A. I asked Mr. Head if he had heard about Messrs. Casebourne. He said, "What about them?" I said I had been told that a firm in Genoa, Simango and Company, had failed, owing Casebourne a large sum of money—I believed about £8000—and that in consequence Casebourne had come to grief. I also said that I had been informed the three principal creditors were the owners of the West Hartlepool Ironworks; Dorman, Long, and Co.; and Fry, I'Anson and Co.; that a ship-load of girder iron, ready for sea, and intended for some firm—a Genoa firm—had at the last moment been stopped at Messrs. Dorman and Long's wharf; and that Mr. Gladstone had either gone or was going to Genoa to see what could be saved from the assets of the firm there.

Q. You told practically what Mr. Hill had told you?—A. Yes.

Q. Did you hear it from other sources as well?—A. I did.

Q. Not from Hill; you heard it from other persons?—A. Yes, from other persons.

Q. When you made the communication you believed in the truth of it?—A. I had not the remotest doubt at the time.

Mr. WADDY: I do not ask you anything.

Mr. LOCKWOOD: Now I will call Mr. Hill.

Mr. Justice CAVE: We have nothing to do with Mr. Hill, have we?

Mr. LOCKWOOD: No, my lord; perhaps not. Then I will not go any further. That is the evidence on behalf of the Defendants.

Mr. WADDY: My Lord, I now propose to call several persons who were on 'Change that day to say that there was no such rumour as this abroad, as far as they know, at all.

Mr. Justice CAVE: I do not see how that affects the question at all. Mr. Jamieson says he told this to Head, and Head inquired of I'Anson. That is enough, surely. Mr. Jamieson says he told this to Mr. Head, and Head says he inquired of I'Anson. No amount of rumour could alter that.

Mr. WADDY: They say it was a current report on 'Change. I want to deny that; but I do not care very much about it.

Mr. Justice CAVE: That is not material. Practically the only question here is the amount of damages.

Mr. LOCKWOOD: That is so from my point of view, my lord. May it please your lordship—gentlemen of the jury: I now come to the end of this case, which certainly has given me some little anxiety, because I cannot help feeling that my learned friend in opening this case to you did not quite represent the conduct of the newspaper I have the honour of appearing for in the light in which I think it is fairly entitled to be represented. I have already endeavoured, as far as my poor powers go, to vindicate the position of the paper and to put before you, not with any attempt at gloss or exaggeration, the course of conduct pursued by them from the time when this unfortunate mistake was made. That it was an unfortunate mistake, the newspaper, to their cost, know. That Mr. Head knows; and Mr. Head, I am sure, from the way he gave his evidence, has impressed you with the fact that he did what he did quite honestly, and was actuated by nothing approaching to any improper motive; and the most my learned friend can say is, that he was careless, and ought to have made other inquiry than he did. He had direct information brought to him, which my learned friend and I are in a position to trace. But he did not rest upon that; he also had a conversation with I'Anson, which he has detailed to you. That conversation with I'Anson confirmed the report which he had heard, and on that he acted. If you should think there has been anything reckless in the conduct of Mr. Head, or this paper, that is one thing. But if you think he has been merely mistaken and committed an act of carelessness, no doubt, but that the mistake was not committed rashly or recklessly, then I trust you will take that view—namely, the second view—and that view will affect the verdict which you will be called upon to give. Now one word with regard to the explanation given as to the trading

account of Mr. Ray. I do not want to make any false point before you, but I think that the observation made by Mr. Casebourne through my learned friend gives sufficient explanation with regard to that. The dates there represent actual deliveries, when payment was made. There is one other observation I would also make on that ledger account, which is that it shows really that the trading account with Ray was a very great portion of the business of Casebourne and Co.; that, in fact, these five firms in respect to which my learned friend in opening claimed special damage—Caspar, Ray, the Steel Company of Scotland, the Consett Iron Company, and another—that the total trading in 1885, the total turnover of these five firms, only amounted to £1600 out of a total trading of the firm of £46,000. Therefore, of this they have only been able to show any damage, or any suggested damage, in the case of Caspar and in the case of Ray; and no attempt was made to support my learned friend with regard to the Steel Company of Scotland, the Consett Ironworks, or the other firm the name of which I forget. My learned friend has limited himself to these two firms, and I submit, with regard to these two firms, my learned friend has not made out any case really for substantial damages. I find during the course of this case and the cross-examination, and from the attitude which my learned friend took up with regard to Mr. Head, that evidently there was a feeling of soreness or my learned friend would not have cross-examined him in the way he did. I do not know what the intention of Mr. Casebourne may be with regard to Mr. Head, whether he intends to bring another action against him to claim all this over again; but judging from the course adopted by my learned friend, it is evident to me that there is some intention of that kind; and if there is, then you know my learned friend is not entitled to visit all this upon the defendant newspaper if he has got this other shot in the locker, which was in a very unmistakeable way indicated by his cross-examination. I am in the dark with regard to what Mr. Casebourne's intentions are, but probably we shall hear a declaration from Mr. Waddy that he has no intention, on the case of Mr. Casebourne, to bring an action against Mr. Head; but, however, I will watch and see what my learned friend has to say about it. If he does not make that declaration of his policy we know pretty well all the sin in connection with this matter ought not to be visited on the head of this paper, and I shall wait with interest to hear my learned friend announce absolutely that he has no intention on the part of the plaintiff whatever to bring any action against Mr. Head. I am not going to weary you gentlemen by addressing you at any length. I have ventured, as far as I can, to represent the conduct of this paper in the light in which I think it should be regarded if it does come to be a question for you to assess damages. I ask you not to assess them on the commercial basis, which my learned friend has utterly failed to substantiate, but on the principle of doing temperate justice between the parties in this case.

Mr. Waddy:—My lord, and gentlemen,—I have been waiting from the beginning of this case to the end with the greatest curiosity. I have had a great amount of curiosity about which now I do not mind unbosoming myself to you. My learned friend has had absolutely an undefended action to try to defend. What was the meaning of it? Why was it fought through from beginning to end, instead of the proper thing being done and some adequate compensation offered to the plaintiff and some proper settlement made? We claimed by that ridiculous letter of ours—as I dare say he thinks, and perhaps you may think—£10,000 damages. Of course, I do not say, gentlemen, that that is anything like the sum you are going to give, but what I want to know is this: Why did not they pay into court, if there was no real *bonâ fide* defence, something substantial, instead of this ten guineas, which is amusing. But, gentlemen, I now see through it. I thought we should have it out before we got to the end of the case, and it has been like they say the post-script of a young lady's letter frequently is, that the important part of it is in the very tail—in the postcript. We now see that this action has been fought for the purpose that my learned friend might, if he could fight this one action, stand between the two stools, try and pump out of counsel on the other side a pledge with regard to Mr. Head, and so wriggle and twist out of his liability in some kind of fashion between the two. I now understand it. It has been reserved to the last, and now my learned friend stands here and challenges me to make a declaration which he knows I cannot make, which he knows very well I have no power to make, which he knows also has nothing on earth to do with this matter, and the only meaning of which, he will forgive me for saying, is that it is the only way to save covetous Mr. Head and these people, because it is all one concern to Healeys and the Heads together. I ask you, gentlemen, to give adequate damages and compensation now to my client. What I have put before you is the moral of what my learned friend has said, and nothing more or less. Now let us pass from that, because that was all good-humoured badinage on his part, and I hope I have dealt with it in the spirit in which it was put forward. It is a question, as my lord said just now, of damages. With regard to the only suggestion that Mr. Head was moved by malice, when I first opened this case to you, I said distinctly that I alleged nothing of the sort. There is no malice; but the mischief of it I repeat now, as I practically said, is that without a particle of malice of any sort, these newspaper correspondents, in order to fill up their columns, will stick in anything, and they do not care how it hurts people; and rather than take the trouble to inquire whether it is true or not, they say, "Oh, but my parcel must go off to-night!" and then they stick things in about people which they have not verified. It is important, they think, that the world should be possessed of the information at once—it will not keep a week; and so, rather than wait a week, they will run the risk of doing Messrs. Casebournes irreparable damage in order that they may be quite sure that The Engineer of January, 1881, may enlighten the world upon the subject. Well, gentlemen, I say that is simply intolerable. I do not know what your opinion may be upon the subject. I have no right to inquire, except in the form of your verdict; but I venture to say that it is intolerable. Newspapers seem to think that they have some kind of public duty to perform. Directly a man chooses to buy a certain amount of type and a printing press, he immediately becomes "we;" and becoming a "we," he thinks he has a right to say that Jones is about to become insolvent, or that Robinson is in a very bad state financially. Now, a newspaper proprietor has not any right conferred upon him by Government to libel folks; and if he does do it, he is not to get off by getting an eloquent and learned counsel, like Mr. Lockwood, to come and say, "This is an unfortunate mistake," and make out that he is to be pitied as a poor newspaper proprietor. Then, says my learned friend, "the poor unfortunate man did all he could, as soon as he found out his mistake." Yes; but what reparation is that? It does not put the thing right because, as Mr. Ray said, "I see the paper, but only occasionally." You remember the letter I read—I will not read it over again—where they said the retractation made was such a beautiful thing that it put them in a better position than they were before. Now, how about Mr. Ray? "I see it occasionally," he said; "I happened to see that one, and not the other." You do mischief by the first statement, and you never can put it right. It is all very well for counsel to come and say, "Oh, it was an unfortunate mistake, and we have done our best to rectify it." I do not want you, gentlemen, to give inflamed damages at all, but what I want you to consider is simply the real mischief that has been done. My learned friend says we have not called all the people we might have called. We simply could not. In a case of this sort all we can do is to give general evidence, and to give one or two illustrations to show the damage that we have sustained. We have called Mr. Ray; and if we had called all those persons—these Flensbergs, from wherever they may come, or these Elsinore people—and if we had got people from Holland and Germany, a nice little bill of costs there would have been, and we should have been very properly told that we had been running up costs in the most disgraceful way, which would have to be paid by the defendant. What we have done, gentlemen, is to put before you general evidence. We have given you only illustrative cases, because in point of fact it is quite impossible for these two men to tell you the damage which has been done, or which may be done, by it. You start a tale of this sort running, and you can never catch it again; you start a mischief of this sort once rolling, and you can never thoroughly stop it. I give them credit for doing the best they can, but they cannot stop it. It has been said, give a lie half an hour's start, and it will run round the world before you can catch it. That is invariably the rule. It is so with things of this sort; they give it a week's start. It must go off that week; and it was Mr. Head's earnest desire to give it a week's start. He succeeded, and the mischief has been done. Now, gentlemen, with regard to figures, I am bound to say that Mr. McInlay did not give us the beneficial result which we might have expected from an accountant. But when we got the clerk in the box, who was more conversant with the way in which the books were kept, there was no difficulty. Now what do we say? As a matter of fact, no reason has been suggested for this falling off in the business, except the one accusation. Mr. Ray was called, and you heard what Mr. Ray said. I called Mr. Hardy, and I read you Mr. Hardy's letter. I put it to you, gentlemen, and no doubt many of you may be men of business, how would you like to read a letter from a customer telling you that, although he had been dealing with you for a long number of years at certain periods, he now regretted—they always do regret it, I believe, very much—to say he could not give you the usual three months' credit or take your bills; but he would trouble you on every occasion to "down with the dust." That is not a nice sort of thing, and it is a damaging thing, and you do not get over a thing of that sort in a hurry. Says my learned friend, "Afterwards you saw the retractation." There is no retractation in it. "Yes," says Mr. Ray. Gentlemen, I do not care to split hairs in the matter. "Do you think that makes it up to me? You tell me that John Jones is going to be bankrupt, and you let all the world know it, and you tell me the next week that he is not going to be." Do you think, gentlemen, that that improves his position? No, and therefore from him afterwards I will have cash. The plaintiffs tell you that they believe they have been damaged to the extent of 90 per cent. of their business. That may be an exaggerated view which they naturally took of their own case and their own injuries; but, gentlemen, figures cannot lie. In the first four months of 1885—the time fixed by my learned friend, and I have given those figures simply because he fixed that time himself—the contracts made were £10,000, and in the first four months of the next year they were £3000. That is a difference of £7000 in the work done. That is strongly indicative of the damage that was done. Now, gentlemen, I will not occupy you more than two or three minutes longer. It is not a fact that the whole of the work was done in one or two contracts. £4000 out of £6000 was done in small contracts, which appear in the invoice book which is here. There have been no large contracts since. Now look at the importance of that case, you can judge of that for yourself. Am I not right in this? I ask you as men of business the meaning of that. As to the small contracts, the cash, those continued to some extent, though not entirely, but the larger matters, the matters of credit, those are gone. My learned friend then puts in all the turnover. That is not the question, because if the contract was made before this rumour or libel began, if that had been the case, then one easily could understand that the business must nevertheless go on, and the turnover does not give us the slightest information. The question is what fresh contracts did people choose to make with them, and the answer is what I have given you. Gentlemen, I will not weary you further. The only further observation I will make is this—I cannot help thinking that if it was intended to bring anybody here to show that they had taken ordinary and common care, in that view it was no use to bring Mr Jameson. Why did not they bring Mr. I'Anson? We might have got the truth from him; there was Dorman, Long, and Co., the truth might have been got from them; Gladstone and his firm, the West Hartlepool Company, it might have been got from them; or best of all, Casebournes, it might have been got from them. From whom did he inquire? From I'Anson, he says. He supports his evidence by Jameson; that he thought it desirable to do, but he does not bring I'Anson, the person who, he says, confirms it, and I should like to have heard from Mr. I'Anson's own lips the words he would speak to, for we had three different accounts given of it. There the matter rests. I do not care to throw any discredit on Mr. Head further than that of carelessness, which is acknowledged on his behalf, and I must say carelessness not only in the way of hurry, but as to the welfare of other people; and I do say, gentlemen, that I have shown here a damage so large and so substantial—which we cannot prove to a penny, a shilling, or a pound—a damage which may go on in the future, that I venture to suggest that you will give substantial damages, not absurd inflammatory damages, to my client for the injury which has been done him.

Summing Up.

Mr. Justice Cave: Gentlemen of the Jury,—This is an action for libel, in respect of which the defendants have paid ten guineas into court, and have pleaded that that was sufficient. I do not suppose I am doing them any injustice in telling you that there is very little doubt that it is not regarded at all as being a satisfaction, and that it will be for you to say how much more the plaintiffs ought to have. Now it was said, Why not pay a larger amount into court at once? We lawyers all understand why that is not done. Whatever amount you pay into court, a jury will always give more; that is an invariable rule, and if you want to get at their real view of what the damages should be, pay a small amount in, and leave them to say what more there should be. That is regarded as a rule by all lawyers, and you may take that as amounting to an invitation to you to fix what you consider the fair and proper sum under all the circumstances. Now what should the damages be? In the first place, undoubtedly it is clear that the plaintiffs ought to recover whatever damage they have actually sustained—all pecuniary damage they should undoubtedly recover. What that is it is difficult to say. Probably you are much better judges of that than I am. We had their books produced, and divers witnesses put in the box with reference to that. Now Mr. McInlay, the accountant who was called, undoubtedly did not give us very much information. I rather think the matters which he was called on to prove did not really lie within the scope of an accountant's duties at all. The real person to tell us that was Mr. Foster, the clerk, and, really, all that Mr. McInlay did do, and could do, might have been done perfectly well by any clerk who was capable of dealing with figures, and really he was called more to give a sort of dignity to the case than anything else. You must look substantially at what Mr. Casebourne says in the matter. In the first place, what is the damage which would naturally follow? You know that much better than I do, because you are business men; but one would say the first and natural damage would be loss of credit. If Casebourne and Co. had been able before to deal on terms of credit, when people heard they had failed, even although this was corrected subsequently, showing that all they had done was to make a bad debt, what persons dealing with them would do, would be to limit the terms of their credit—either refuse to give them credit altogether, considerably diminish the amount of credit given them, or require security of some kind. Therefore, that is one thing which would happen to them, and it would be accompanied of course by some amount of annoyance when they came on 'Change and had to meet the people with whom they were accustomed to deal. Now loss of credit may probably go on and extend further; extend, that is to say, to actual loss of business, and that will depend, to some extent, on the position in which the firm happen to be. If the firm, of whom this statement is made, is a peculiarly strong, wealthy firm, it may not inconvenience them; it would be a great annoyance, nothing more—they would be compelled to pay cash instead of credit. On the other hand, if the firm was not a very strong firm, and especially if they had recently met with a very serious loss, the being compelled to pay cash may render it necessary for them to draw in their dealings, and in that way would be an actual business loss. With reference to the actual business loss here, some figures are given us by Mr. Foster to the effect that the sales in 1885 were for the first four months £10,000, and those of the first four months of 1886, £3000. If one could take that as being a sum which one could justly calculate on, you would have to consider what the loss of profit was that that loss of business represented. It seems to me you cannot quite deal with that on that footing; for this reason: that these transactions in which Messrs. Casebourne and Co. engage are not transactions of so small and numerous a character as to make four months a good average. Where transactions are small and numerous, of course four months would be a fair time for an average; but if the transactions are few and large, then, of course, four months is hardly a sufficient time to get a really satisfactory average. I illustrate it for instance in this way. During the last month before January the 8th, there was only one transaction (I am speaking now of large sales of iron and steel), and during the first four months in 1885 there were only three which amounted to the larger portion of that £10,000. I do not know that we have been told exactly what they were during the first four months of 1886; but there again it is tolerably obvious that a large transaction on May the 1st, or in the early part of May, would seriously affect the average. There are hardly enough transactions to get at an average, so that you must exercise some discretion in dealing with those figures—how you should deal with them you will know better than I do. These are merely matters that occur to me that you will give effect to or disregard according as you may, from your superior knowledge of business, think they are, or are not, worthy of consideration. So much on that part of the case—as well as you can get at it you should give Casebourne the damages he has actually sustained in consequence of the publication of this libel. Then, gentlemen, there is a second head of damages which you may or may not take into consideration, according to the circumstances of the case, that is what is called exemplary damages. In a case of libel, in a case of slander, in a case of assault, and divers other cases of that kind, juries are not confined to the actual damages sustained, they have a right to take other matters into their consideration as well, and have a right to consider the whole of the circumstances under which the injury is inflicted; and, undoubtedly, if the injury is inflicted attended with remarks of insolence and contempt, and things of that kind, a jury may make exemplary damages the greater part of the damages awarded. Now therefore, gentlemen, I must say a few words to you with reference to what has taken place here. Under what circumstances has the libel been inserted in the paper, and what has been done since? We have got Mr. Head's account of what took place, and certainly—I agree it is a question entirely for you—it seems to me what Mr. Head did hardly justifies the whole of the remarks made on the subject by the learned counsel for the plaintiff. This is how the matter stands. On the 29th of December Messrs. Casebourne and Co. had written to Messrs. I'Anson and Co. in these terms:—"We very much regret to inform you that, owing to a heavy loss, we are unable to meet our engagements. Our creditors are only three—viz., Messrs. Dorman, Long, and Co., Middlesbrough; the owners of the West Hartlepool Ironworks; and Messrs. Fry, I'Anson, and Co., Darlington. As we wish to lay a statement of our affairs before you, we shall feel greatly obliged if you will meet at the offices of Messrs. Dorman, Long, and Co.," and so on. Now, that letter it appears was sent to I'Anson and Co., and, understand, to them only; but everybody knows that if you tell a second person anything in the nature of a secret, why, it is more or less at the mercy of the world. People do not, as a rule, keep other people's secrets, and therefore there always is some danger of the thing coming out. Under those circumstances, it seems as early as the 2nd December Mr. Jameson said he heard it from Mr. Hill, and when he got on 'Change at Middlesbrough, on the 5th January, he told Head about it. Now, Head says—Thereupon I went and saw Mr. I'Anson. So far, he was right. Undoubtedly, he was bound not to take the statement of Jamieson, who was not a creditor, but to go to head-quarters, if he could, and ascertain if it was true or not before venturing on publishing it. Now, of course, I am dealing only with the question how far his conduct was excusable; it does not justify it. Nothing will justify you publishing what is untrue, but the circumstances under which it is published may to a greater or less extent excuse what has been done. He goes to I'Anson and gets from I'Anson an account which substantially confirms what Jamieson had told him, and led him to send this paragraph off to the paper. Now, then, it is said he ought further to have gone to Casebourne and Co. No doubt that would have been the proper course to have taken, and if he had gone to Casebourne and Co. before making this announcement, the announcement would never have appeared, and The Engineer would not now be called on to pay damages for its having appeared. He did not do that. He rested satisfied with the statement of Jameson

and I'Anson, and although more prudence would have saved his principals altogether, yet it is for you to say whether they ought to be visited, and to what extent, if any, with the payment of exemplary damages, because he did not take the further step of consulting Messrs. Casebourne and Co. Next we come to this: the letter is sent off on the 6th, and on the 8th of January it is published. Then on the 11th of January Mr. Parrington, the solicitor to the plaintiff, writes a letter in which he states that he has been consulted by the plaintiffs about these statements which he is instructed to say are untrue. Messrs. Casebourne and Co. have not failed; they made a bad debt, and the vessel you mention was stopped by them by an injunction obtained at their instance from the High Court. "My clients having large business connections both in England and on the Continent, I need hardly say that such statements as these, disseminated as they will be through the English and continental press, are calculated to do them immense harm." Then they ask for damages. To that there is an answer on the 13th January in which "The Editor of THE ENGINEER presents his compliments to Mr. Parrington, and acknowledges receipt of his letter of the 11th inst. The editor regrets exceedingly the statement referred to, which upon inquiry he finds from his local correspondent to have been written under a misapprehension of the facts. It seems that Messrs. Casebournes' affairs were a matter of common conversation on 'Change in consequence of the firm having taken some of their more considerable creditors into their confidence. The editor repeats that he very much regrets the occurrence, and will, of course, be glad to give equal publicity to a contradiction of the report. He proposes to insert in a prominent place in this week's issue a statement in the form enclosed, if approved by Mr. Parrington's clients, and doubtless with this reparation Messrs. Casebourne and Co. will be satisfied. The editor would ask for a reply by telegraph." Then comes the correction. Now, of course, I am not for a moment surprised that the plaintiffs were not satisfied with that reparation, because, as I have had already occasion to observe once before these assizes, it is not a sufficient reparation, or anything like a sufficient reparation, if a libel has been inserted in a newspaper, to insert thereupon a contradiction, and suppose that puts an end to the matter; it does not, and ought not, to put an end to the matter, and for many reasons. In the first place where a paragraph appears reflecting upon anybody, there is a sort of natural love of scandal in the human race, and people read it, and go about, and when they meet anybody say, "Have you heard that terrible thing that has happened to Casebournes, they have stopped payment;" and so it gets spread about in all quarters; and when, next week, the correction appears, do you think that any of these people who went about telling the failure would tell the correction. Not at all; they would leave that to take care of itself. It is in that way the mischief is done, and reparation by contradiction is childish—it is no reparation at all. Then with regard to the contradiction which was inserted, something was said about its not improving the matter. I must say I do not see any particular harm in the correction itself. It is in these terms:—"We regret very much the statement made in the letter of our North of England correspondent which appeared in our last impression to the effect that Messrs. G. E. Casebourne and Co., of West Hartlepool, had failed. It appears that a large foreign customer of that firm had stopped payment, but we are informed that Messrs. Casebourne and Co., beyond being sufferers by the loss, are not affected in their business, and that the steamship, to which reference was made, was not stopped by a creditor, but by Messrs. Casebourne themselves. We repeat our expression of regret that the passage in question should have appeared in our columns." The substance of that was actually furnished by Mr. Parrington's letter, and I can very well understand what took place. Mr. Parrington says in reply: "Must leave it to your discretion what you publish by way of retractation; cannot accept it as reparation for so serious an injury." Now I must say I think if they were going to say that the actual language of the correction would make the matter worse, that they should have said so, and said we object to that form of correction. I do not think he was called on to state what sort of correction would suit them, or to intimate their satisfaction with any proposed form of correction, because undoubtedly if they had done that it might have been said when the matter came afterwards before a jury, "You come here and complain that we have not done what we ought to have done, you actually yourself settled the form of the paragraph to be inserted in correction." I do not think a person who is libelled is called on to do that, and he may fairly do what was done in this case; say you have published a libel, I must leave you to insert what correction you think proper, but if the correction is submitted to them, and it does do them, as they think, a further injury, I think they should point that out and say at the same time the correction you send is, we think, calculated to injure us still more, and we tell you why. That seems to me to be the fair thing between the parties, therefore I do not think there is any very great ground of complaint of this proposed correction. Then on the 15th of January the correction is inserted, and on the 20th there is another letter from Mr. Parrington after he had seen Mr. Head. "Dear Sir, Mr. Head called on me yesterday urging the acceptance of your retractation as complete reparation. I could only tell him that I would submit what he said to my clients and take their further instructions, which I have done to-day. They, however, feel very strongly that they should have adequate pecuniary compensation, urging that at the very time when business and credit were most essential to them to enable them to repair their loss, they have, though perfectly solvent, suffered serious loss in both through the statement in your paper. I am, therefore, sorry that I shall have no alternative but to issue you a writ, and if you will let me know the names of your solicitors I will send it to them to save any annoyance connected with personal service." That seems a very proper letter indeed. They were not, as I say, bound to accept the correction as a reparation, but at the same time I cannot help thinking, if they really felt there was any ground for complaining of the language in which the correction was to be inserted, they should have taken that opportunity of saying so. I rather think they felt satisfied with the correction, and that that is nothing more than a flourish of counsel, which you need not pay very much attention to. Gentlemen, that really concludes the correspondence. The Editor writes again, in which he says, "He is sorry that Messrs. Casebournes do not realise that the correction which appeared in THE ENGINEER must be of infinitely more value to them than could the erroneous notice be harmful." I have already said I think that is perfect rubbish. Editors must take the utmost pains and trouble to prevent libels appearing in their papers, and if libels do really, notwithstanding their care, appear in their papers, why then they must pay damages. It is idle to suggest that a mere contradiction does away with the whole of the evil done by inserting the libel. I do not think, gentlemen, there are any other observations I need trouble you with. I have simply to ask you to say whether you consider ten guineas a sufficient satisfaction, and if you do not, then will you say how much more the plaintiffs ought to receive.

The jury retired to consider their verdict at ten minutes to two, and returned into court at a quarter past three.

The Associate [Mr. WADE]: Gentlemen, have you agreed?

The Foreman: We have.

The Associate: Do you find for the plaintiffs or for the defendants?

The Foreman: For the plaintiffs.

The Associate: What amount?

The Foreman: £1500.

Mr. WADDY: In this case, will your lordship give me judgment and a certificate?

Mr. Justice CAVE: Yes.

(The damages have been paid into Court, and a motion for a new trial is now pending.)

THE PHYSICAL SOCIETY.

AT the meeting of this Society on May 22nd, Professor Balfour Stuart, president, in the chair, Messrs. C. A. Bell, J. C. Johnson, and James Swinburne, were elected members of the Society.

The following communications were read:—"On the Sympathetic Vibrations of Jets," by Mr. Chichester A. Bell. It has been assumed hitherto that a gaseous or liquid jet vibrates under the influence of a limited range of tones only, effective tones being those which do not differ greatly in pitch from the normal or proper tone of the jet discovered by Lavart and Sondhauss. The author has found, however, that when the pressure under which a jet escapes is not too great, the latter is affected by all tones lower than the normal as well as by some above it. Changes may be excited in a jet of either kind by vibratory motions of the jet orifice, or of the fluid behind, or external to the orifice. These changes take the form of slight swellings and contractions, which become more pronounced as the fluid travels away from the orifice, and finally cause the jet to break or become discontinuous at a distance which depends upon the intensity of the initial disturbances. At any point within the continuous portion of the jet the successive swellings and expansions represent both the form and the relative intensities of vibrations impressed upon the orifice; and the jet is therefore capable of reproducing very complex sounds, such as those of speech and music. A vibrating jet of air does not, however, emit sound when it plays with free air, or into the wide end of a tube communicating with the ear, but when it plays against a very small orifice in the end of a hearing tube, loud sounds may result. This reproduction is most intense when the hearing orifice is placed in the axis of the jet, just within the breaking point; but becomes gradually feebler as the hearing orifice is moved towards the jet orifice, or out of the line of its axis. Beyond the breaking point the sounds from the jet at first become confused, and finally are lost. A jet of gas, like a liquid jet, only vibrates so as to produce its normal tone when it strikes upon some obstacle which serves to diffuse the disturbances due to impact, or throw them back upon the orifice. The vibrations of an air jet are also loudly reproduced as sound when it is directed against a small flame below the apex of the blue zone. Liquid jets are but slightly sensitive to aerial sound impulses, but become highly sensitive when the jet tube is rigidly attached to a sound-board. The vibrations of a jet so mounted are best perceived as sound when the stream strikes upon a rubber membrane tied over the end of a narrow tube which communicates with the ear. For accurate reproduction of speech and sounds in general, the jet should be at such a pressure as to respond visibly to a note of about 4000 vibrations per second; and the membrane should be at such a distance from the orifice that the jet never breaks or becomes discontinuous above its surface. The vibrations of very fine jets of any conducting liquid become loudly audible when a portion of the jet or the "nappe" formed when it strikes upon a flat surface is included in circuit with a battery and a telephone. This may be accomplished by letting the jet impinge on the end of an ebonite rod, through the centre of which passes a platinum wire. The upper end of the rod is surrounded by a short tube or ring of platinum, the upper margin of which forms a continuous, slightly convex surface with the exposed end of the central wire and the ebonite. The wire and ring form the terminals of the circuit which is completed through the nappe. Distilled water containing $\frac{1}{300}$ of its volume of pure sulphuric acid is recommended as the jet liquid. The author advances a new theory to account for the growth of the vibratory changes in liquid and gaseous jets.

"On some Thermodynamical Relations," Part V., by Professor W. Ramsay and Dr. S. Young. In Parts I. and II. of this series of papers it was shown that the ratio of the absolute temperatures of any two bodies corresponding to a given vapour pressure bears a simple relation to the ratio at any other pressure, which may be expressed by the equation $R^1 = R + c(t^1 - t)$. Where R^1 and R are the two ratios, c is a constant, and t^1 and t are the temperatures of one of the two bodies. The determination by Schumann —*Pogg. Ann.* N. F. 12,46—of the vapours of methyl formate and twenty-seven homologous ethers made it possible to compare the vapour pressures of a large number of bodies belonging to the same class. It was found that when the ethers were compared with ethyl acetate, which was taken as the standard, in every case $c = o$, and therefore $R^1 = R$. The temperatures corresponding to the three pressures, 200, 760, and 1300 mm. are given by Schumann. Taking the mean value of R for those pressures as correct, and recalculating the temperatures, the greatest difference between the found and the recalculated temperatures is 0 7 deg. C. The vapour pressures of water or any one of the ethers being accurately known, it is sufficient to determine the boiling point of any ether belonging to this class, in order to construct its vapour pressure curve. The absolute temperatures corresponding to the pressures 200 and 1300 mm. for any ether are $\cdot 89795t$ and $1\cdot 0488t$, where t is the boiling point at normal pressure in absolute temperature.

A gridiron slide rule by Mr. Stanley, designed by Mr. Thacker, was explained by Mr. C. V. Boys. It was equivalent to a slide 60ft. long, and performed multiplication and division with an error not exceeding the 140,000th part.

Specimens of safety explosives, and their results in shattering blocks of lead, were exhibited by Mr. H. Sprengel.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, May 22nd.

THE anthracite coal companies of Eastern Pennsylvania are fighting over trade in the West and South. New England shipments are quite heavy from New York and Philadelphia. The production is now 110,000 tons per day. This month's allotment was 2,000,000 tons, but in the month of June 2,400,000 tons will be mined, according to the decree of the committee which met on Thursday. The demand for anthracite has been steadily increasing. The Reading Company contemplates the construction of more abundant shipping facilities to Baltimore, where it will come into competition with bituminous coal from the West. The Pennsylvania Company is perfecting facilities on the Chesapeake Bay whereby it can handle larger quantities of bituminous and anthracite for shipments to various points along the Atlantic Coast. A great deal of bituminous territory has been developed last year and this, and more will be developed this year. Within the past year a great deal of coal-carrying capacity has been lost, and in consequence freights are a little higher both on coal and lumber. The manufacturing demand for fuel is steadily increasing in the New England and middle States. Coke shipments from the Connelsville region have increased from 10,000 to 13,000 tons per day, and the entire Connelsville region, producing over 60 per cent. of the entire coke used in the United States, is running over full capacity.

The demand for iron and steel has been slightly checked during the past few days, but there are reasons for saying that the compensating activity will be developed in a very short time, because of the announcement on the part of builders and architects that deferred operations will be revived on June 1st. Steel rails are selling at 34 dols. to 36 dols.; merchant bar, 1·75c. to 2c.; nails, 2·10 dols. to 2·25 dols. per keg, with 2000 machines still idle in the West. The plate mills are booking a good many small orders.

Locomotive works and shipyard orders are improving little by little. Heavy car orders have been secured this week, especially from the trunk lines. The pipe works are still crowded with orders for pipe, both wrought and cast. The textile manufacturing establishments are running well considering that this is the dull season. The boot and shoe manufacturing establishments are running fully three-quarters time, and will run full from June 15th.

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

(From our own Correspondent.)

IT is in pig rather than in finished iron that the market is at present showing most animation. The exceptionally favourable prices now prevailing are inducing consumers to come forward in some directions, and they are operating in Derbyshires, Leicestershires, Northamptons, and Lincolnshires with some amount of freedom. Native pigs do not offer such advantages to buyers as these outside brands. Certain long-established ironmasters there are, however, whom nothing will tempt just now to contract forward. They declare that all previous contracts have gone against them.

The prices that are ruling transactions are very low, and are declared to be largely profitless. Although 34s. is still quoted for Northampton pigs delivered, and 35s. for Derbyshires, yet Derbyshires are known to be selling at 32s. 6d., and Northamptons at hardly above 30s. Some sellers there are, however, who sternly decline any such price as 32s. 6d. Lincolnshire pigs are selling at 37s. 6d. to 39s. delivered. Native forge pigs have got down very low, and 27s. 6d. is freely talked of. Indeed, some native foundry pigs may be had at 30s. to 32s. 6d. The Apedale brand of North Staffordshire pigs is 40s. delivered in South Staffordshire. All mine pigs are selling at 50s. to 55s. for hot blast sorts, while cold blast are 75s. to 80s. nominal. Hematites show but little movement at 50s. to 52s. 6d. delivered.

In the sheet trade, although it is estimated that some sixteen or eighteen mills have been either partially or wholly stopped in the past six months, yet the supply continues excessive. Now Messrs. Groucutt have re-started their Bankfield Ironworks, Bilston, the millmen having consented to a reduction of some 2½ per cent. in wages, and it seems likely that other adjoining works at present closed will shortly be again on. Thus it seems impossible to curtail the supply for long together. Sheets of 20 gauge are £5 15s. to £6; 24 gauge, £6 to £6 5s.; and 27 gauge, £7 to £7 2s. 6d.

The entry of new firms into the galvanised sheet business has not a good effect upon prices. Galvanised sheets of 24 gauge, packed in bundles delivered to Liverpool, are quoted £9 15s. to £10 and upwards, according to the brand. Sheets of 26 gauge are quoted £11 5s., and 28 gauge £12 per ton upwards.

The Shrubbery Steel and Iron Company, Wolverhampton, has now set its forges going at its new sheet works erected upon one of the sites formerly occupied by Messrs. E. B. Thorneycroft and Co. In a few days the mills will be in active operation, and it is hoped that before very long four mills will be kept running, and by-and-bye some 200 hands will be found employment.

The plate trade is unimproved, and districts more favourably situated are taking the bulk of the business. Tank plates are quoted £7 and upwards, and boiler sorts £8 to £9, with best sorts going on to £10.

Marked bars are selling at £7 12s. 6d. and £7; second-class branded bars, £6; good merchant bars, £5 10s.; and common, £5 down to £4 15s. Hoops are now selling at from £5 for common sorts up to £6 10s. for superior makes. Gas strip is abundant at £4 15s. upwards.

Engineers are still being pressed for orders by representatives of Belgian girder houses. The continental manufacturers are evidently very unprepared to give up the business without a struggle, notwithstanding that Messrs. Dorman, Long, and Co. claim that they have now got their prices down to within 5s. per ton of the Belgian makers, and that the difference of 5s. is more than compensated in the superior quality. Belgian deliveries have recently been delayed into this district by reason of the strikes and riots, and some orders have been two months in filling. Indeed, engineers here state that they can never rely on deliveries under a month if they be in lots of, say, 20 tons and upwards which are supplied from Belgium direct. For such lots the price of standard sizes, such as 10in. by 5in. and 12in. by 6in., is about £5 to £5 5s. per ton delivered Birmingham. If only small lots are needed quickly out of stock in London, about £6 per ton is the figure charged.

The strikes at the Trench and Stirchley Ironworks, Shropshire, against a heavy reduction in wages have now entered on the fifteenth week, and there seems no probability of a settlement. The men have offered to submit the dispute to arbitration, but this the masters decline, and are filling up the vacancies with any men who may offer themselves at the reduction. The Trench Company has thus been enabled to restart one of the mills with outsiders, who have been joined by a few of the old hands.

The constructive ironwork manufacturers are in receipt of fair orders for bridge purposes, and girder sections for new large business establishments and several gasometer contracts are in negotiation. The heavy ironfounders have less to do on mill and forge work, but pillars, lamp-posts for export, telegraph cast iron supports for foreign countries, and general castings are in moderately good request. The light ironfounders complain of the dearth of business, but considerable activity is noted in the production of dynamo machines, fittings, and various electric lighting and heat appliances.

Interest is taken here in the first general meeting of Spiel's Patent Petroleum Engine Company in London on Tuesday. The chairman, Mr. Heritage, announced that when the company was formed two months ago a special license was granted to Messrs. Shirlaw and Co., of Birmingham, who were to make the engines, the company also reserving power to manufacture. The board, however, considered it well to obtain the co-operation of Messrs. R. Hornsby and Sons, of Grantham. Both firms had now agreed to manufacture the engine under royalty, and it was believed that the sale would be large. The board had also made arrangements for placing the manufacture of the engines for South America in the hands of Messrs. Hornsby. This would be of great advantage to the company, but it had not been formed for supplying engines on the American continent. The directors proposed that the company should acquire the patent rights of the continents of North and South America, re-selling them to a subsidiary company. A resolution to this effect was carried.

The strike at Messrs. Edwin Lewis and Sons' Wrought Iron Tube Works, Wolverhampton, has now come to an end, the men having resumed upon the firm's own terms, which was a considerable reduction in wages. At other works in the Wednesbury district this example is now almost certain to be followed.

If the same spirit evinced by Eliza Tinsley and Co., of Old Hill, near Dudley, is shown by other nail-making firms there soon may be an end to the disaffection of the nailors of South Staffordshire and East Worcestershire. Writing to the secretary of the Nail-makers' Association, the firm say that they should be pleased to go back to the 1879 list if other nail masters would do the same. They have no desire to see men working at wages below the list, and any reductions which they had imposed were made in the last extremity when their competitors generally had adopted such a course. It is satisfactory to note that Messrs. Tinsley are extending their nail-making business, they having acquired the works

carried on at Catshill, near Bromsgrove, by Messrs. Enoch Hadley and Co.

The Duke of Abercorn's committee at South Kensington are industriously arranging for the entertainment of Indian and Colonial visitors to the Exhibition during the ensuing two or three months. Not only is it proposed to show them hospitality in London, but arrangements are being made for their inspection of leading provincial towns under official auspices. Birmingham is prominent among the centres which it is thought the visitors would like to inspect, and the Duke of Abercorn has just communicated with the Mayor of Birmingham, inquiring whether it would be agreeable to his worship and the Corporation to arrange some date on which they would be willing to offer a reception to a party of Indian and colonial gentlemen, and afford them facilities for inspecting the objects of interest in the town. The Corporation have at once fallen in with the suggestion, and the 29th inst. has been named as the day on which the visitors may be expected.

At a meeting of the Birmingham Chamber of Commerce at the close of last week, an address on the silver question was delivered by Mr. H. R. Grenfell, ex-governor of the Bank of England. He attributed the prevalent depression largely to the change in the monetary values which had been steadily taking place since 1873, and advocated an international system of bi-metallism.

NOTES FROM LANCASHIRE.

(From our own Correspondent.)

Manchester.—There is again little or nothing that is really new to report with regard to the condition of the iron trade in this district, and except that perhaps the market is, if anything, rather weaker, the position remains unchanged. A few of the leading firms seem to be making a stand against any further giving-way in prices, but in the open market it is difficult to say at what price iron could really be bought until sellers are tested by actual offers. The demand, however, for both pig and manufactured iron continues of the most meagre description, and there is very little business offering to really test prices. Forge proprietors, who are the chief users of pig iron in this district, are so short of work that they are not taking anything like their ordinary quantities, and the same remarks apply in a lesser degree to founders, whilst in many cases consumers are already considerably over-bought. The result is, that notwithstanding the present restricted production, a large quantity of pig iron is being thrown upon the hands of makers, and although some of them are strong enough to hold, there are weak sellers who are driven to seek for orders, which buyers who happen to be in the market are able to place almost on their own terms.

There was about a fair average attendance on the Manchester iron market on Tuesday, but business all throngh was extremely flat, and I could hear of no transactions of any weight either in pig or finished iron. For local brands of pig iron makers still quote 37s. to 37s. 6d., less 2½, for delivery equal to Manchester, and they do not seem disposed to come below these figures, although they are practically out of the market, except where they are able to book occasional small orders to regular customers. For one or two of the Lincolnshire brands a stand is also being made at about 36s. 6d., less 2½, as the minimum figure for delivery into the Manchester district; but this figure is equally out of the market as a competing price in the face of the much lower figures at which most of the district brands can be bought, and there is some exceptionally low-priced iron at present being offered which has a weakening effect upon the market. Scotch and Middlesbrough irons can be bought here at quite as low prices as ever.

There is perhaps, if anything, a little more business doing in hematites, but it is still of no weight, and prices continue very low. For Cumberland brands makers quote about 51s. to 52s., less 2½, for No. 3 foundry delivered here, but local makes are to be got at considerably under these figures.

In the finished iron trade the business doing continues of a hand-to-mouth character, with prices stationary at about £4 17s. 6d. to £5 per ton for bars, £5 7s. 6d. for hoops, and £6 10s. for sheets, delivered into the Manchester district; makers are, however, so badly off for work that sometimes prices are cut even below these figures to secure prompt orders.

The reports with regard to the condition of the engineering trades continue very discouraging. In many cases the past winter has brought a more severe strain upon engineering concerns than has ever before been experienced, and trade still shows no sign of improvement. The weight of new work coming forward is extremely small, and the competition for it is so keen that it is only in very special cases that it is being secured except at unremunerative prices, and in all the leading branches of the general engineering trade, including locomotive and engine builders, tool-makers and machinists, works are but indifferently employed.

Of course it is only to be expected that the lighter branches of industry largely dependent upon the engineering trades for employment should be feeling severely the present depression. Nut and bolt makers complain that orders never were so scarce, or prices so much cut up, as at present; and both brass-founders and iron-founders report that there is extremely little work giving out from engineers, and that for this there is an excessive competition, which so presses down prices that only the barest margin of profit is possible under the most favourable circumstances.

Messrs. Oldham and Richards, of Manchester, have patented a new coupling for tubes or rods. This coupling, which is of very simple construction, is cast in halves, and in the place of the parallel or diagonal slot which is used with many of the couplings, a slot is cut in each end transversely to the direction of the tube or rod. By this arrangement the liability to wear slack or pull asunder it is claimed is overcome, and Messrs. Oldham and Richards have certainly produced a coupling which is very handy either for connecting or disconnecting, and as it requires no delicate or special machinery for its manufacture, it is one which possesses special advantages for railway companies and contractors.

In the coal trade there has been, with the commencement of the month, a levelling-down of prices in the Manchester district to the summer rates which were ruling at this time last year, and in other districts there has been some giving way in the price of round coals; but here and there in best slack, of which the production is now very small, prices have been put up about 6d. per ton. The demand generally is only very dull, and all classes of fuel for iron making, steam, and general trade purposes still meet with an extremely slow sale. At the pit mouth prices average about 8s. 6d. to 9s. for best coal, 6s. 9d. to 7s. 6d. seconds coal, 4s. 9d. to 5s. 6d. common coal, 4s. 3d. to 4s. 9d. burgy, 2s. 6d. to 3s. common slack, and 3s. 9d. to 4s. 3d. for the best sorts.

The reduction of prices in the Manchester district has been accompanied by a reduction in the wages of the colliers of 10 per cent., and in the wages of day men, both underground and on the surface, and of the wharf men and carters, of 1s. per week.

Barrow.—There is a quieter demand for hematite samples of pig iron, and the disposition on the part of buyers to place orders is not displayed in so marked a manner as has been the fact lately. The business doing in pig iron, however, is sufficiently large to give anticipation of a continuance of the present improved activity at makers' works which is now observable. On home account a very fair inquiry has been experienced, while from the United States there is a good demand for iron ore, pig iron, and Bessemer blooms. Large consignments of these three articles have already been ordered, and it is probable they will be followed by others. It is, of course, impossible to expect a large trade in steel rails, because the prohibitive tariff, along with freight charges, put British producers out of the market. A good business can, however, be done in steel blooms, as they are admissible at a nominal tariff. On Continental account there is a poor inquiry, and on general account not much life is shown in the demand for pig iron. The stocks of pig iron are smaller than they have been, especially in the neighbourhood of Barrow. Prices are steady at undisturbed rates, 42s. per ton being the price for mixed numbers of Bessemer pig iron net at works, prompt delivery, and 41s. for No. 3 forge or foundry samples. Steel makers are busy on orders for steel rails for Canada and elsewhere, which will find them employment for several months to come. Prices remain steady at about £3 15s. per ton net, but buyers are asking lower prices. These, however, buyers are refusing to give, and are bargaining for lower values where they can. Engineers are indifferently employed. Shipbuilders have booked no new orders, although some are offering. Iron ore is in quiet demand; coal and coke steady. Shipping better employed, but freights are low.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

IN spite of the extraordinary depression in the colliery industry, another undertaking was commenced on the 31st ult. at Killamarsh, a village about eight miles from Sheffield. Mr. G. T. Earle, accountant, Sheffield, acquired 90 acres of the minerals near Killamarsh railway station, the Duke of Portland being the surface landlord. He has leased the coal, at £60 per acre, to Mr. G. Hunter, certificated manager, of Bishop Auckland, who estimates that he has secured a seam of steam coal, 5ft. to 5½ft. thick, and about 45 yards from the surface. On the 31st ult. Mr. Earle performed the ceremony of turning the first sod of the shaft for what will henceforth be known as "The Earle Mine." The operations were watched with much interest by the villagers. It is expected that the pit will be at work in three months.

On Wednesday, June 2nd, the mayor—Alderman Jno. Pye Smith—formally opened the new sewage works for Sheffield, which are situate at Blackburn Meadows. The system is similar to that which has been in operation at Bradford since 1874. It is the intermittent, precipitation, and filtration system, the invention of Mr. C. Alsing, C.E., who designed the works at Bradford, and has designed and personally superintended the erection of the works and machinery at Blackburn Meadows. The buildings and the tanks cover 7½ acres of the 23 acres purchased for sewage treatment. The cost of the land was £12,000, and the buildings, tanks, and machinery have cost an additional £30,000. The total length of new main sewers in the main drainage scheme is about sixteen miles, the dimensions varying from 6ft. 6in. diameter to 3ft. by 2ft., and the cost of the works is estimated at £104,716. The total expenditure on sewage works and main drainage will thus be pretty near the sum borrowed for the purpose —£150,000. The extent of the town area drained by the new sewers is about 4000 acres, and the estimated average quantity of sewage which will be conveyed to the new works is 10,000,000 gallons per day. The new sewers are stated to be large enough to provide for the wants of the town for a long period, even if it should increase at the extraordinary rate it has done for the last twenty-five years. Messrs. Wm. Bissett and Son, Sheffield, were the contractors for the sewage works. The main sewer works were divided into two contracts. The largest, including all the more important works, was let to Messrs. Pearson and Son, of Delahay-street, Westminster. Mr. Charles Gott, M.I.C.E., Bradford, designed and carried out the main drainage scheme, as Mr. Alsing, C.E., did the new sewage works.

An exhibition of gas stoves, gas engines, gas baths, &c., is being held at Chesterfield, under the auspices of the Chesterfield Gas Company, and promises to be a successful enterprise.

At Elsecar, on Whit Tuesday, the Princess Mary, Duchess of Teck, is to open the Wentworth and District Exhibition, of which Earl Fitzwilliam, K.G., is president, and the Archbishop of York the patron. The exhibition is to consist of two classes, the first, workmen, and the second, amateurs, manufacturers or merchants. The successful exhibitors in the first will receive pecuniary prizes, and the second, certificates of merit. The object of the exhibition is to promote industrial excellence and a taste for art among the miners.

Mr. Joseph Rodgers, of Selwyn Court, Richmond, Surrey, a director in the well-known firm of Messrs. Joseph Rodgers and Sons, cutlery manufacturers, Norfolk-street, Sheffield, died on the 26th ult., and was interred at Richmond General Cemetery on the 28th ult. Deceased, who was only 28 years of age, was the eldest son of the late Mr. George Rodgers, and grandson of the late Mr. George Rodgers, one of the founders of the great cutlery firm in Sheffield. On his father's death, in 1883, he took his place on the board of the company, and assumed direction of the London house. Being in feeble health he went to Australia in February, 1885, returning in September, however, very little, if any, better for the voyage. In November he attended the directors' meeting at Sheffield, which was the last visit he paid to the town. There are five directors on the board, and Mr. Rodgers' death makes the second vacancy since Christmas. The four surviving directors are Mr. Robert Newbold, the chairman; Mr. F. Bardwell, J.P.; Mr. Arthur Newbold; and Mr. M. G. Rodgers.

THE NORTH OF ENGLAND.

(From our own Correspondent.)

ENQUIRIES for Cleveland pig iron have been rather more numerous during the last few days, and the tone of the market has been a shade firmer. There was not a large amount of business done at the market held at Middlesbrough on Tuesday last, but the returns showing a decided improvement in shipments during the past month, made both makers and merchants less despondent, and encouraged consumers to consider the advisability of covering their sales. Prices were much steadier than they were a week ago, and merchants were quite firm at 29s. 4½d. per ton for No. 3 g.m.b. for prompt delivery, and makers would not quote less than 30s. Forge iron is still offered at 28s. 6d. per ton, the demand being slack owing to the continued depression in the finished iron trade.

Holders of warrants are offering them at 29s. 9d. per ton, but buyers will not give more than 29s. 3d. to 29s. 6d.; consequently no sales are made.

The stock of Cleveland pig iron in Messrs. Connal and Co.'s Middlesbrough store was on Monday last 241,273 tons, being an increase of 4895 tons for the week, and 19,514 tons for the month.

Exports of pig iron from the Tees during the month of May were heavier than in any previous month since October, 1885, and about 5000 tons more than in May, 1885. The quantity sent away was 71,037 tons, Scotland, the best customer, taking 27,111 tons; Germany, the next best, taking 9230 tons; France, 4325 tons; Norway and Sweden, 4069 tons; Russia, 3970 tons; Italy, 3840 tons; and Belgium, 3320 tons. Shipments of manufactured iron and steel also show some improvement, 42,820 tons having been sent away in May, against 35,265 tons in April. India was by far the best customer last month, 19,343 tons having been sent to that country.

The finished iron trade is no better, there being only two or three works in the district which are fully and continuously employed. Prices are unaltered. The steel makers have orders on their books sufficient to last some months, but prices are miserably low.

The meeting of the shareholders of the Consett Iron and Steel Company, called to consider the proposals of the directors to raise fresh capital, and extend the company's operations, was held at Newcastle on Saturday last. Mr. Dale, the chairman, presided, and explained clearly what was intended to be done. The action of the directors was entirely approved by the shareholders. The general confidence in this undertaking is such that the existing shares, which carry with them the right to purchase a proportion of new ones, have already advanced substantially in value.

A new house for the use of the officers of H.M. Customs has just been erected and brought into use on Eston jetty. In future vessels entering the Tees will be able to stop there and undergo examination, instead of as heretofore being bound to go up to Middlesbrough in any case. This will effect a great saving of time in cases where the lower reaches of the river are the ultimate destination.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE Glasgow pig iron warrant market, which was firmer at the close of the past week, has this week been very quiet, with a downward tendency in prices. This is attributed, in part at least, to the shipments being considerably less than those of the previous week, when there was some expectation that they would be comparatively large. The total quantity shipped was 9887 tons, as compared with 12,828 in the preceding week and 11,413 in the corresponding week of 1885. Two furnaces have been extinguished at the Clyde Ironworks, and one has been put in blast at Carron, the total number now blowing being 89 as compared with 91 at this date last year. The week's addition to stocks in Messrs. Connal and Co.'s Glasgow stores has been about 5900 tons. During the five months of the year now gone the total quantity added has been 99,624 tons.

Business was done in the warrant market on Friday at 38s. 6½d. cash. On Monday the tone was quiet, a small business being done at 38s. 6d. and 38s. 5½d. Tuesday's market was also very quiet at 38s. 5½d. to 38s. 6½d. cash. Business was quiet on Wednesday, with little or no change in prices. To-day—Thursday—transactions took place grom 38s. 8d. to 38s. 7½d. cash.

The current values of makers' pigs are as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 42s. 6d.; No. 3, 40s. 6d.; Coltness, 46s. and 42s. 6d.; Langloan, 43s. 6d. and 41s. 6d.; Summerlee, 45s. and 41s. 6d.; Calder, 46s. and 40s. 6d.; Carnbroe, 42s. and 39s. 6d.; Clyde, 42s. and 39s.; Monkland, 39s. 3d. and 36s.; Quarter, 39s. and 35s. 6d.; Govan, at Broomielaw, 39s. 3d. and 39s. 6d.; Shotts, at Leith, 44s. and 43s. 6d.; Carron, at Grangemouth, 47s. 6d. and 44s. 6d.; Kinneil, at Bo'ness, 43s. and 42s.; Glengarnock, at Ardrossan, 42s. and 39s. 6d.; Eglinton, 39s. and 35s. 6d.; Dalmellington, 40s. 6d. and 37s. 6d.

The arrivals of Middlesbrough pigs at Grangemouth for the week were 7285 tons, against 8165 in the preceding week, and 6473 tons in the corresponding week of last year.

The general manufacturing iron trades are fairly active at present, with exceptions here and there. Locomotive builders are in some cases much in want of orders, but there is a large business doing for abroad in a variety of goods, such as sugar-crushing plant, sewing machines, plates, sheets, and pipes. The steel nail trade is also very brisk, but makers complain bitterly of the low rates at which they are obliged to sell. It is expected that the break-up of the Scottish Steel Makers' Association will enable some houses to compete more successfully with outside manufacturers.

In the coal trade there is considerable activity in the shipping department. The week's shipments have been 21,282 tons at Glasgow; Greenock, 1286; Ayr, 8470; Irvine, 2825; Troon, 6286; Burntisland, 12,754; Leith, 1580; Bo'ness, 14,056; and Grangemouth, 12,106 tons. The inland branch of the trade is quiet, and the prices of all sorts nominally unchanged.

At a meeting of the Mining Institute of Scotland, held in Glasgow a few evenings since, Mr. Ralph Moore, her Majesty's Inspector of Mines, submitted some notes on American mining machinery, in which he described certain novelties capable of adaptation to mining operations in this country.

During the past month sixteen new vessels were launched from the Clyde shipyards, with an aggregate tonnage of 13,913, as compared with 23 vessels of 18,927 tons in May, 1885, and 28 of 28,570 in 1884. The output for the five months has been 57 vessels measuring 65,225 tons, against 96 of 78,440 in the same period of last year, 116,070 in 1884, and 149,949 tons in 1883. Only about a third of the tonnage put into the water in the course of the month is made up of sailing vessels, and it is worthy of note, as showing the high favour in which steel is held by builders and owners, that about three-fourths of the entire output is of that material.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

AS stated in THE ENGINEER last week, the Bute Dock Bill has been piloted into smooth water. The last opposition has been withdrawn, and Sir W. T. Lewis scores a great success. There is, of course, the formation of the company and the gathering of capital, but upon that head there need be little distrust; and if, as I imagine, the linking of the two railways—the Rhymney and Great Western—should ensue, the tranquillisation that would follow in the local railway world would be akin to that produced in the mining world by the operation of the sliding scale. The railways working under one direction, and in harmony with the Bute Docks, would really be a grand thing.

The reduction of wages at Dowlais, Cyfarthfa, and, in fact, all the steel-works of the "hills," has been carried out. This has been 10 per cent., dating from June 1st, and it is felt keenly. There were several days of suspense, and in more than one quarter a strong influence existed to resist it; but from the first the mass of the ironworkers regarded the reduction as inevitable. The fact that it was almost an impossibility to get six days' work per week, and that three, four, or at best five days, comprised the rule, showed how little demand there was for rails even when prices fell to 70s. per ton, and hence the reasonable part of the community have been enabled to persuade the remainder.

I am afraid that it is a long time since wages were so low at the ironworks. Common labour, chiefly performed by the Irish, varies from 10s. to 13s., and the most skilled ranges from 20s. to 23s.

The reduction has not been carried out without some few exceptions. I hear that at Dowlais a number of men were paid off, and doubtless from there and other works there will be emigrations to the tin-plate districts, where better wages are supposed to be obtainable. Trade at all the steel works continues slack and unremunerative. Makers say that they cannot see any light ahead at present. No shipments beyond those of a very ordinary character have been reported. Iron ore imports have slightly increased.

The improvement in the patent fuel trade of Cardiff continues, and I am glad to note that a compromise has been effected between employers and the dock men. Large quantities have been shipped to India and other destinations this week.

The coal trade remains in very similar condition to that of last week. Some little vitality exists in the steam, and particularly in small steam, and a few of the major collieries are busy. I have seen much more briskness of late in the Rhondda valley. In the Aberdare valley it is not so good. The drift at Pennar is to be stopped, and in other collieries reduction is imperative, and lessened staffs of men certain. In the Monmouthshire district the average is three to four days a week, and some of the collieries are being worked out, rendering migration imperative. Gwerna coke ovens are busy; elsewhere coke-making is being abandoned in the Rhymney valley.

It is rather pleasant in these depressed days—for we are not out of the wood yet—to hear of new coal companies. The Caerphilly Company has just been started, to acquire the Llantwit and Black Vein Colliery, in the parishes of Rudry and Eghoysilan—capital, £30,000.

In the Ynysyfeio the working of one seam has been abandoned, but the men will be employed on others.

I am unable so far to announce the successor to Mr. Wales. With regard to the coroner, a good man has come forward in the person of Mr. Kleys, a barrister, nephew of the chairman of the Merthyr Guardians, who has claims upon the county for public and able services superior to any I know.

The tin-plate trade is rather dull; buyers are waiting, hoping to see lower figures than 13s. for coke, and they expect with the starting of Ystalyfera extra rivalry in competition will bring this about. Last week's quotations prevail, but are rather unsteady. Stocks are slightly on the increase at Swansea. Good business is going on at Newport, and I am pleased to see that coal shipments are looking up. The unusually heavy shipment of over 20,000 tons took place on Friday last.

NEW COMPANIES.

THE following companies have just been registered:—

Anglo-Vasco Navarro Railway Company, Limited.

This company was registered on the 26th ult. with a capital of £570,000, in £20 shares, to acquire the concession granted by the Spanish Government for the construction and working of a railway from Estella to Vittoria and Durango, with a branch from Arroniz to Lerin. The subscribers are:—

	Shares.
Lieut.-General F. R. Mannsell, 15, The Grove, Boltons	1
J. McMillan, 5, Paper-buildings, Temple, barrister	1
J. M. de Artola, Chislehurst, banker	1
J. A. M. Cope, 14, Pembridge-square, solicitor	1
G. de Artola, 48, Aubert Park, Highbury, banker	1
A. Wilson, C.E., Heath Royd, Lewisham-hill	1
W. J. Dickinson, Selhurst, Surrey, accountant	1

The board will consist of three London directors (London Board), and three residing in Spain (Spanish Committee); qualification, 50 fully-paid shares. The subscribers will appoint the first London Board. The directors in England and Spain will each be entitled to an annual fee of £300 or 7500 pesetas.

"Affinitan" Disinfectant Company, Limited.

This company proposes to trade as manufacturing chemists, and will purchase the letters patent No. 852, dated 7th January, 1884, granted to Alfred John Shilton, for the manufacture of a new disinfectant known as "Affinitan." It was registered on the 26th ult. with a capital of £20,000, in £1 shares, with the following as first subscribers:—

	Shares.
A. J. Shilton, 40, Paradise-street, Birmingham, analytical chemist	1
S. R. Buttenshaw, St. Albans, accountant	1
H. E. Warren, 20, Budge-row, secretary Brighton and Dyke Railway	1
E. B. Denton, Ganic, near Barnet	1
W. Ralfe, 1a, York grove, Peckham, clerk	1
E. Smith, jun., 29, Edgware-road	1
H. G. Davies, 73, Ludgate-hill, accountant	1

The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, 250 shares; remuneration, £600 per annum, and also one-tenth of the net profits in each period in which 10 per cent. per annum dividend is paid.

Blundell's London Copper and Brass Works, Limited.

This company proposes to purchase the business of the late Thomas Blundell, engineer, coppersmith, brass and iron founder, carried on for many years at 23 and 25, West India Dock-road. It was registered on the 22nd ult. with a capital of £10,000, in £10 shares. The subscribers are:—

	Shares.
F. W. Shorey, 5, Pennyfields, Poplar, engineer	1
H. Ives, 78, Canton-street, Poplar, engineer	1
S. Shore, 65, Grundy-street, Poplar, engineer	1
W. J. Baker, 3, Silver-terrace, Millwall, coppersmith	1
H. V. Geary, 107, Malmesbury-road, Bow, accountant	1
J. B. Goodhugh, 9, Great Ormond-street, W.C., agent	1
C. J. Jones, 90, Montpelier-road, Peckham	1

The number of directors is not to be less than three nor more than five; qualification, shares of the nominal value of £200; the subscribers are to appoint the first, and act *ad interim*. The company in general meeting will determine remuneration.

Channel Islands Granite Company, Limited.

This company proposes to acquire and work a quarry or quarries in Jersey or elsewhere, and to trade in stones, minerals, &c. It was registered on the 21st ult. with a capital of £60,000, in £1 shares. The subscribers are:—

	Shares.
Thomas Hayward Budd, 33, Bedford-row, solicitor	1
E. Hayward Budd, 89, Gloster-terrace	1
J. Hibberd, 106, Greenwood-road, Dalston	1
G. J. Marr, 30, Cornford-grove, Balham	1
J. G. Hilton, 88, Harmood-street, Haverstock-hill	1
D. E. Hart, 15, Winchester-road, South Hampstead	1
W. M. Hopkin, 9, Baronet-terrace, Tottenham	1

The number of directors is not to be less than two nor more than seven; the names of the first will appear in the company's prospectus; the company in general meeting will determine remuneration. Messrs. Armstrong and Co., Limited, of 34, Old Broad-street, are appointed sole agents for the sale of granite and other articles dealt in or sold by the company.

Colchester Electric Light and Power Company, Limited.

This company was registered on the 24th inst. with a capital of £25,000, in £10 shares, to carry on in Colchester and elsewhere in England the business of an electric light company in all branches. The subscribers are:—

	Shares.
*Thos. Moy, Stanway Hall, near Colchester, merchant	20
*J. Cooke Hopwood, Lexden-road, Colchester, silversmith	20
*E. Smith, St. Mary's Lodge, Colchester, land agent	20
*E. J. Sanders, Cambridge-road, Colchester, merchant	20
E. T. Smith, Beverley-road, Colchester, solicitor	20
*H. Grimwade, Head-street, Colchester, land agent	20
J. Paxman, Hythe-hill, Colchester, engineer	10

The number of directors is not to be less than three nor more than seven; qualification, £200 in shares; the first are the subscribers denoted by an asterisk. Each ordinary director will be entitled to £1 1s. for every board meeting attended, and the directors will be further entitled to such additional remuneration as may be voted them by the company in general meeting.

Barrington Cement, Lime, and Brick Company, Limited.

This company was registered on the 26th ult. with a capital of £100,000, in £5 shares, to trade as cement, brick, and tile manufacturers and lime burners. The subscribers are:—

	Shares.
R. Barnes, 45, Finsbury-pavement, solicitor	1
E. O. Preston, 4, Tokenhouse-buildings, financier	1
H. Young, 4, Tokenhouse-buildings, financier	1
E. Bell, Cambridge, merchant	1
A. H. Clarke, 39, King-street, Covent-garden	1
A. H. Webb, Cambridge	1
F. A. Cooper, 21, Finsbury-pavement, commission agent	1

Registered without special articles.

Cooper's Patent Glass-lined Tube Company, Limited.

This company proposes to manufacture glass-lined or other iron or lead pipes or tubing, and for such purpose will acquire and work the letters patent No. 4461 of the year 1878, and No. 14,356 of the year 1884. It was registered on the 20th ult. with a capital of £50,000, in £5 shares, with the following as first subscribers:—

	Shares.
General Thos. Addison, Melton, Suffolk	1
H. Dudley Cooper, Wimpole-street	1
Lieut.-Col. W. Marvin, 45, Agate-road, W.	1
W. Smallpiece, C.E., 122, High Holborn	1
A. Wood, 31, Agate-road, W., agent	1
C. H. Austin, 48, Alma-road, Wandsworth, shorthand writer	1
J. Cartwright, 20, Leighton Park-road, Essex	1

The number of directors is not to be less than three nor more than seven. Most of the regulations of Table A are adopted.

Kinta Alluvial Tin Company, Limited.

This company proposes to acquire the interest of Messrs. Crawford, D. Kerr, and Randall Howell Pye, in a concession from the Regent of Perak, of 204 acres 2 roods and 14 poles of land, in the Rasôk Valley, Kinta, and of two town sites in Telôk Anson, a point on the Perak River. Power is taken to carry on mining operations, to construct public works, and to erect a line or lines of telegraph, and to transmit and convey messages by the company's wire, and to make charges, and to receive payment therefor. It was registered on the 20th ult. with a capital of £50,100, divided into 50,000 ordinary shares of £1 each, and 100 founders' shares of £1 each. These latter shares will be allotted to the founder or founders of the company in accordance with an agreement of the 10th ult. (unregistered), and will entitle the holders thereof to one-hundredth part of one-tenth of the net profits as declared by the directors in any year, payable out of any surplus remaining after payment of dividends upon any preference shares for the time being issued. The subscribers are:—

	Shares.
H. O. Jeyes, 25, Westbourne-terrace, merchant	1
*A. Rooke Turner, C.E., Kinta, Straits Settlement	1
Edwin Brett, 7, Birchin-lane, stockbroker	1
A. W. Rixon, 10, Austinfriars, solicitor	1
G. Woodgate Hutchinson, 89, London-wall, accountant	1
Isaac Carr, 10, Austinfriars, clerk	1
H. G. Saunders, 7, Portugal-street, W.C., law stationer	1

The first directors are Messrs. Metcalfe Larken (local managing director in the Straits Settlement), H. J. H. Hogg, A. R. Turner, C.E., and R. H. Pye, the last of whom will join the board upon adoption of the agreement above referred to. Mr. Turner will be entitled to a remuneration of £75 per lunar month so long as he manages the business at Kinta; the remuneration of the other directors will be at the rate of £100 per annum each up to the time of the ordinary general meeting in 1887, and subsequently they will receive such sum as the company may determine; qualification, for future directors, 100 shares.

Johore Development Committee, Limited.

This company proposes to acquire property in the territories of the Sultan of Johore, in the Malay Peninsular, for mining and other purposes, and in particular will acquire a concession granted by the Sultan on the 11th of March, 1886, to Messrs. Edmund Gabbutt, H. Jenks, H. B. Vercoe, B. Rodyk, T. Scott, and L. J. R. Glass. It was registered on the 26th ult. with a capital of £12,000, in £50 shares. The subscribers are:—

	Shares.
*Thomas Scott, 1, Whittington-avenue, merchant	1
*Henry Jenks, Blundellsands	4
*L. J. R. Glass, 1, Whittington-avenue, merchant	1
J. B. Vercoe, Keswick, engineer	4
R. Marshall, 187, Evering-road, Clapton, clerk	1
*B. Rodyk, 13, Leinster-square, Bayswater	7
*E. Gabbutt, Club Moor, Lincoln, contractor	4
C. Wells, Bootle, quarry proprietor	2

The number of directors is not to be less than three nor more than seven; the first are the subscribers denoted by an asterisk; minimum remuneration, £1 1s. to each director for every meeting attended.

Sussex Electric Light Company, Limited.

This company was registered on the 25th May with a capital of £20,000, in £5 shares, to enter into contracts for electric lighting and for the supply of electric energy for power or transmission. The subscribers are:—

	Shares.
John Sayer, 25, Norfolk-road, Brighton, engineer	1
S. Prince, 48, West-street, Brighton, accountant	1
C. J. Allen Davis, 48, West-street, Brighton, photo artist	1
C. E. Beard, Lewes	1
H. Prince, 12, Middle-street, Brighton, solicitor	1
H. E. Ayres, 27, Stanford-avenue, Brighton	1
Col. W. H. White, 41, Albany Villas, Brighton	1

The number of directors is not to be less than three nor more than five; qualification, £250 in shares or stock; the subscribers will appoint the first.

Steam Rocking Hobby-horse Company, Limited.

This company was registered on the 21st ult. with a capital of £1600, in £1 shares, to introduce to the public the latest improvements in hobby-horses or roundabouts. The subscribers are:—

	Shares.
J. P. Halstead, Sowerby Bridge, carriage builder	50
A. Porter, Darwen, agent	5
J. Rushworth, Sowerby Bridge, engineers' pattern maker	30
W. Wilkinson, Darwen, photographer	5
S. Bedford, Queen's-road, Halifax, decorator	5
J. J. Butterworth, Heyworth, confectioner	5
J. Barnes, Darwen, mineral water manufacturer	1

Most of the articles of Table A apply to the company.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Applications for Letters Patent.

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

25th May, 1886.

6973. COMPOUND MARINE STEAM ENGINES, J. Howden, Glasgow.
6974. OBTAINING COPPER FROM SOLUTIONS OF SALTS, E. Hunt.—(*G. Thomson, United States.*)
6975. STRETCHING, &c. WOVEN FABRICS, J. Hawthorn and J. P. Liddell, Manchester.
6976. PINDER'S PATENT VOLCANO, G. Pinder, Edwinstowe.
6977. MANUFACTURE OF FERRO-MANGANESE, &c, C. J. Sandahl, G. Bargate, and C. B. Phillips, Chester.
6978. TEA AND COFFEE POTS, W. Bateman, Birmingham.
6979. DOUBLE SAFETY BROOCH FASTENER, F. Clews, and J. Argyle, Birmingham.
6980. DRIVING BELTS, H. Markus, Manchester.
6981. CARDING ENGINES, F. Wilkinson, Halifax.
6982. MANUFACTURE OF CHAINS, &c., J. Ford and E. Ford, Birmingham.
6983. ADDITIONS TO WEIGHING MACHINES, G. Salter, Birmingham.
6984. TOILET SOAP TABLETS, R. Jaques, Newcastle-on-Tyne.
6985. FORMING NAIL-HOLES AND BUTTONS OF PARTLY SHAPED AND DRIED TILES, &c., S. Turner, Lincolnshire.
6986. SEPARATING LIQUIDS FROM SOLIDS, C. H. Roeckner, F. L. Roeckner, and R. L. Roeckner, Tynemouth.
6987. SMOKING TOBACCO IN CIGARETTE FORM, J. M. B. Baker, London.
6988. DYEING COTTON, &c., J. Smith, Manchester.
6989. COMPOUND FOR WASHING, &c., PURPOSES, A. Watt, Manchester.
6990. ENDLESS ROPE CLIPS FOR COLLIERY, &c., PURPOSES, J. Beatty, Sheffield.
6991. INCIDENCE WINDOWS, &c., L. Nelke, London.
6992. MACHINES FOR CORRUGATING SHEET METAL, L. L. Sagendorph, London.
6993. PACKING CONFECTIONERY, &c., J. R. Stout, London.
6994. REGULATING THE FLOW OF OXYGEN, HYDROGEN, &c., GASES, A. Brin, London.
6995. STEAM BOILERS AND OTHER FURNACES, H. Thompson, London.
6996. PNEUMATIC SOUNDBOARDS OF ORGANS, W. A. H. Drechsler, London.
6997. LAMPS, F. Rhind, London.
6998. REFLECTOR LIGHTS FOR BAKERS' OVENS, F. H. V. Houten, London.
6999. DISTILLING AMMONIA, W. C. Wren, London.
7000. SKATES, C. L. Peirce, London.
7001. GRATE BARS, I. W. Swallow, London.
7002. BOILERS, J. Sephton, Halifax.
7003. ELECTRO-MAGNET TRANSMITTER, A. H. Reed.—(*J. T. Williams, United States.*)
7004. GENERATING CURRENTS OF ELECTRICITY, R. E. B. Crompton, London.
7005. LUBRICATORS, C. Adams and R. Weatherburn, London.
7006. COUPLING AND UNCOUPLING RAILWAY VEHICLES, J. P. Waldie and W. Cook, Glasgow.
7007. CLOSING LEAKS IN SHIPS AT SEA, G. Watson, Glasgow.
7008. STEEL SLEEPERS, W. Evans, London
7009. REFLECTORS, R. T. Strangman, London.
7010. STEAM ENGINES, T. Snowdon, London.
7011. HOUSEHOLD SIGNALS OR BELL INDICATOR, T. Morris, Alloa.
7012. WHEELS FOR ROAD VEHICLES, B. Brunon, London.
7013. HORSE COLLARS, G. F. Redfern.—(*Gabez-Létienne, France.*)
7014. PORTABLE GYMNASTIC APPARATUS, G. F. Redfern.—(*L. J. M. Andrieu, France.*)
7015. AERIAL LOCOMOTION, G. F. Redfern.—(*J. S. Foster, United States.*)
7016. HEATING WATER, L. Jardin, London.
7017. AUTOMATIC DELIVERY OF GOODS ON THE INSERTION OF A COIN OF THE PROPER DENOMINATION, H. A. Schlund, London.
7018. COVERING WITH FABRICS THIN BLADES OR STRIPS OF METAL, &c, J. Dufaux and H. Mathieu, London.
7019. POT COVERS, W. C. Nye, London.
7020. BREECH-LOADING FIRE-ARMS, F. A. Lehmann.—(*R. S. Chaffee, United States.*)
7021. CIGARETTE-MAKING MACHINES, H. J. Haddan.—(*J. Floyd and E. J. and P. McCrossin, United States.*)
7022. SURFACE COOLING, HEATING, &c., APPARATUS, J. C. Mewburn.—(*J. Dietze, Germany.*)
7023. SIGNALLING BY NIGHT, J. G. Howard, London.
7024. SECURING HAIR SPRINGS IN COLLETS, H. Gardner.—(*E. Hunziker, United States.*)
7025. MUSIC and like STOOLS in CAST METAL, J. B. Noyes, London.
7026. DISTRIBUTING VALVES for HYDRAULIC MACHINES, A. Piat, London.
7027. MOUNTING LENSES for PHOTOGRAPHIC PURPOSES, G. Smith, London.
7028. ELECTRIC BATTERIES, G. F. Rose, London.
7029. FORE-SIGHT PROTECTORS for RIFLES, E. Harrison and W. J. Jeffery, London.
7030. GRINDING MOWER KNIVES, R. Dutton, London.
7031. ELECTRIC SIGNALLING APPARATUS, H. H. Lake.—(*The International Dudley Signal Company, United States.*)
7032. LUBRICATORS, H. H. Lake.—(*Michigan Lubricator Company, United States.*)
7033. REEL for COTTON, THREAD, &c., H. H. Lake.—(*J. B. T. G Baudouin and La Société Richard frères, France.*)
7034. WEARING APPAREL, H. H. Lake.—(*A. N. Loring, United States.*)
7035. DIETETIC COMPOUNDS, J. N. Beach, London.
7036. BELT FASTENINGS, J. Walker, London.

26th May, 1886.

7037. SYPHON BOTTLES, &c., W. Bruce and W. Thorne, Birkenhead.
7038. CRUET FRAMES, E. Gibson and J. Lord, Birmingham.
7039. FASTENING HANDLES to BRUSHES, &c., F. R. Baker, Birmingham.
7040. FASTENINGS for GLOVES, &c., J. Cadbury and J. G. Rollason, Birmingham.
7041. RELEASING BRAKE LEVERS on RAILWAY VEHICLES, W. Herald, Godley.
7042. SOWING SEED, J. W. Battershill, sen., and J. W. Battershill, jun., Birmingham.
7043. LAMP STOVE, J. and J. Lind, Liverpool.
7044. POLISHING, &c., YARN, &c., W. G. Bywater and T. B. Beanland, Leeds.
7045. FILTER PRESSES, J. B. Alliott and J. McC. C. Paton, Manchester.
7046. INJECTORS for RAISING LIQUIDS, &c., C. S. Madan, Manchester.
7047. MOTIVE POWER, T. Price, Brierley Hill.
7048. LAWN TENNIS PICKETS, L. K. Scott, London.
7049. MAKING ICE, E. de Pass.—(*E. H. Fluhr, Switzerland.*)
7050. INFANTS', &c., FEEDING BOTTLES, J. W. Jackson, Brighton.
7051. HAMMOCK, R. C. Allan, Leicester.—19*th June*, 1885.
7052. ROLLERS for WRINGING, &c., W. Battersby, Sheffield.
7053. STEERING GEAR for FISHING BOATS, &c., G. Souter, Elgin.
7054. APPARATUS to ADAPT BREECH-LOADING ORDNANCE for PRACTICE with SMALL-ARM AMMUNITION, W. W. Urquhart, Glasgow.
7055. REMOVAL of COALSTONE, &c., W. Patterson, Durham.
7056. LAMPS, W. Taylor, London.
7057. RACKS of CARDING ENGINES, S. Hinchliffe, Leeds.
7058. RAILWAY WAGON COUPLING APPARATUS, F., J. K. and F. Golightly, London.
7059. TEAPOTS, T. Butler, Birmingham.
7060. DOOR CHECKS, C. G. and F. Smith, Birmingham.
7061. DRILL STOCK, J. Mielecki, London.
7062. PREVENTING, &c., PRIMING in STEAM BOILERS, R. Duncan, Glasgow.
7063. TWIST LACE FABRICS, J. Coxon, London.
7064. BRACES or SUSPENDERS, T. Baxenden, London.
7065. SEPARATING LIQUIDS from SOLIDS, &c., J. F Brinjes, London.
7066. TRICYCLES, A. P. Bethell, London.
7067. FLUSHING WATER-CLOSETS, &c., W. Smeaton, London.
7068. FLUSHING WATER-CLOSETS, &c., W. Smeaton, London.
7069. FLUSHING WATER-CLOSETS, &c, W. Smeaton, London.
7070. VAPOUR, MEDICATED, &c., BATHS, W. Smeaton, London.
7071. SANITARY COMMODE, W. Smeaton, London.
7072. POTATO PLANTING MACHINES, W. Kerr, jun., Glasgow.
7073. MATERIAL for COLOURING LIQUID, E. H. A. Heinke, London.
7074. CHAINS for DRIVING, E. C. F. Otto, London.
7075. WEAVING TEXTILE FABRICS, P. M. Justice.—(*W. Weaver, United States.*)
7076. AUTOMATIC ECONOMISER for GAS COOKING STOVES, D. Allport, London.
7077. COURSE CORRECTORS for SHIPS' COMPASSES, J. W. Gillie, London.
7078. GALVANISED IRON ROOFING, S. M. Wilmot, London.
7079. SASH FASTENERS, H. Bridgen, London.
7080. ARC ELECTRIC LAMPS, W. R. Johnston, London.
7081. DIES, C. T. Cayley, London.
7082. WALKING-STICKS, &c., C. Moore, London.
7083. OXIDISING ANILINE BLACK on WOVEN FABRICS, T. R. Shillito.—(*The Zittauer Maschinenfabrik and Eisengiesserei—früher Alb. Kiester and Co.—Germany.*)
7084. MARKING INK PENCIL or POINT, J. Hickisson and E. E. Burnett, London.
7085. SPRING FOLDERS, P. L. Allaire.—(——*Faure, France.*)
7086. LOWERING VENETIAN BLINDS, J. W. Morison, London.
7087. COUPLING and UNCOUPLING RAILWAY WAGONS, W. S. Roe, London.
7088. FILTERS, G. F. Marshall, London.
7089. COMPRESSING SAND CORES, &c., G. F. Redfern.—(*J. N. M. Millott, France.*)
7090. CARTRIDGES, T. Nordenfelt, London.
7091. MACHINES for DOUBLING and TWISTING COTTON, &c., H. H. Lake.—(*S. Etchells, U.S.*)

27th May, 1886.

7092. DEPTH REGISTER, T. A. Mase, Norwich.
7093. SHOT and SHELL, J. F. Hall, Sheffield.
7094. COLLAR and HAMES, A. Baker and W. Nesbitt, Sheffield.
7095. WATER FILTERS, E. Sarjeant, Birmingham.
7096. VENTILATED HANDLES for TENNIS RACQUETS, E. Noyes, Birmingham.
7097. CURLING TONGS, W. B. Hinde, Birmingham.
7098. CONNECTING the ENDS of DRIVING BANDS, &c., S. Ogden and E. Welsby, Manchester.
7099. LOCKS and LATCHES, J. Cadbury and J. G. Rollason, Birmingham.
7100. WEDGES for DOORS and WINDOWS, J. G. Rollason, Birmingham.
7101. FILTERING MATERIALS, J. C. Thresh, Manchester.
7102. ROLLER for PRINTING YARNS, J. Johnson, Glasgow.
7103. GROOVES for DIFFERENT SIZES of STAGE SCENERY, T. Featherstone, Monkwearmouth.
7104. SUSPENDERS for UMBRELLAS, &c., G. Walker, Birmingham.
7105. SPRING BAND for BRACES, &c., G. Walker, Birmingham.
7106. SPANNER or WRENCH, G. Morris, Birmingham.
7107. HOLDERS for INCANDESCENCE LAMPS, R. A. Smith, Birmingham.
7108. PREPARING, &c., COPS, J. Ahlstedt, Manchester.
7109. ELECTRO TELEPHONIC APPARATUS, A. A. C. Swinton, Newcastle-on-Tyne.
7110. PERAMBULATOR BODIES, G. Wedde, Liverpool
7111. ORNAMENTATION of BEDSTEADS, F. R. Baker, Birmingham.
7112. GAS PRODUCERS, W. S. Sutherland, Liverpool.
7113. WITHDRAWING VITIATED AIR from ENCLOSED SPACES, J. Westmorland, Liverpool.
7114. GIRDERS, R. A. Stoffert and T. Dykes, Glasgow.
7115. CORE-BOX, J. Summerscales and H. C. Longsdon, Halifax.
7116. LOCK-NUTS, A. Flamache and E. Picard, Liverpool.
7117. INSULATING MATERIAL, H. Reynolds and W. R. Earp, Liverpool.
7118. CONTOURS from ANIMATE, &c., OBJECTS, J. Hunter, London.
7119. FARE REGISTER, J. Reid, London.
7120. PARTS of STEAM BOILERS, D. Midgley, London.
7121. PHOTOGRAPHIC CAMERAS, G. Lowdon, Dundee.
7122. WATCH-GUARD CROSS-BAR, H. T. Clarke, London.
7123. DECORATION of GLASS VASES, &c., G. Goodyear, Birmingham.
7124. CORNICE RINGS, W. J. Gibbons, Birmingham.
7125. CUTTING UP PLASTIC SUBSTANCES, T. Williams, jun., London.
7126. PRODUCING EMBROIDERY TRIMMINGS, W. Booth, London.
7127. LAMP BURNERS, K. Kubenik, London.
7128. DIVIDED PHOTO-MIRROR, P. Stern and B. C. Le Mousseu, London.
7129. EXTRACTING and SUBLIMING SULPHUR, J. Y. Johnson.—(*C. Dubois, France.*)
7130. WORKING the SCREWS of COGGING and ROLLING MILL ROLLS, L. Richards, London.
7131. PUMP, V. L. E. Miller. London.
7132. PULVERISING, &c, MINERALS, &c., N. Greening, London.
7133. SCREENING LIME, &c., N. Greening, London.
7134. CRICKET BATS, G. Mawer, London.
7135. FASTENINGS for SECURING CHAINS, &c., L. Dove, London.
7136. SEWING MACHINES, W. H. Bland, London.
7137. PRODUCING INDOLDERIVATIVES, C. D. Abel.—(*The Farbwerke vormals Meister Lucius and Brüning, Germany.*)
7138. COAT and JACKET POCKETS, J. R. M. Mallett, London.
7139. PIPE CLEANER, R. C. Annand, London.
7140. HOSIERY MACHINES, J. H. Smith and T. Sellars, London.
7141. CASTING CHAIN CABLES, T. Nordenfelt, London.
7142. ADVERTISING, H. Coste, London.
7143. EDGING for CURTAINS, &c., R. Cragg and C. J. Cox, London.
7144. PLATEN PRINTING MACHINES, C. Butterfield and H. S. Cropper, Nottingham.
7145. DEPILATING and PRESERVING HIDES, A. H. Mangin, London.
7146. WATCHMAN DETECTOR and ALARM APPARATUS, W. Doehring, London.
7147. GALVANIC BATTERIES, E. Tuteur, London.
7148. BOOTS and SHOES, H. H. Lake.—(*W. A. Knipe and G. C. Wadleigh, United States.*)
7149. HEATING WATER, &c., W. T. Sugg, London.
7150. PREVENTING ACCIDENTS by BREAKING of ROPES in MINES, &c., E. Edwards.—(*E. Ogier and G. Chauvet, France.*)
7151. HOLDER for REFLECTORS and SHADES of INCANDESCENT LAMPS, A. L. Fyfe, London.
7152. CRICKET BATS, G. H. White, London.
7153. HORSESHOES, M. H. Petersen, London.
7154. CUTTING or SEPARATING COUPONS, D. Gestetner and W. Binns, London.
7155. PHOTOGRAPHIC CAMERAS, A. S. Newman, London.
7156. PHOTOGRAPHIC SHUTTERS, A. S. Newman, London.

7157. PROTECTING COPPER VESSELS used for SODA STEAM BOILERS, A. M. Clark.—(*M. Honigmann, Germany.*)
7158. STOPPERING BOTTLES, &c., J. C. Schultz, London.
7159. SAFELY GETTING of COAL, &c., in MINES, J. U. Jackson, London.

28th May, 1886.

7160. UTILISING GUTTA-PERCHA, &c., for HORSESHOES, F. Grimsley, Leicester.
7161. WINDOW SASH, B. W. Whiting, Diss.
7162. RAILWAY WINDOW CONDENSATION NUISANCE ABATEMENT, C. E. Pertwee, West Brighton.
7163. HORTICULTURAL and other BUILDINGS, T. C. March, London.
7164. ORNAMENTING METALLIC THIMBLES, C. E. Isles, Birmingham.
7165. MATCH-BOXES, F. R. Baker, Birmingham.
7166. SLEEVE LINKS, G. A. Brown, London.
7167. BALL CASTORS, S. C. Smith, Halifax.
7168. LAMP BRACKET for BICYCLES, &c., F. W. Rosser, Birmingham.
7169. CANDLE SHAPING and MOULDING MACHINES, H. A. Biertumpfel, London.
7170. FASTENINGS of EAR-RINGS, G. E. Carter, Birmingham.
7171. AIR and other PUMPS, J. H. Smiles, Stockton-on-Tees.
7172. COLLARS for HORSES, E. T. Hughes.—(*G. L. Oscar, France.*)
7173. STEAM BOILER FURNACES, F. C. Powell, Glasgow.
7174. TREATMENT of SEWER and other GASES, H. Fewson, London.
7175. NOZZLE, F. Moore, London.
7176. ROTARY PUMPS, J. A. Wade and J. Cherry, London.
7177. ELECTRIC MEASURING INSTRUMENTS, R. Alioth and Co., London.
7178. TORPEDOES, F. H. Beattie, London.
7179. GIVING MOTION to TORPEDOES, F. H. Beattie London.
7180. VALVE COCK, G. Fulda, London.
7181. CARRIAGES, T. Thorneycroft, London.
7182. MANUFACTURING METALLIC TUBES, J. Earle and G. Bourne, London.
7183. NESTS of DRAWERS, T. F. S. Tinne, London.
7184. SAW SETS, F. Hochuli.—(*T. Gibbons and F. Gibbons, United States.*)
7185. WATER GAUGE ALARMS, O. Kreter and A. Bussack, London.
7186. SUGAR TABLETS, F. Bauder, London.
7187. FASTENINGS for STAYS, &c., H. M. Knight, London.
7188. COVERING for BEDS, T. Grison, London.
7189. PRIMARY VOLTAIC BATTERIES, J. E. Pearce, London.
7190. STEAM GENERATORS, W. L. Wise.—(*D'kema and Chabot, Holland.*)
7191. SMELTING IRON, A. Fritschi, London.
7192. CARBONIC OXIDE GAS, A. Fritschi, London.
7193. ANCHORS, G. C. L. Lenox, London.
7194. HYDRAULIC HOISTS, P. G. B. Westmacott, Newcastle-on-Tyne.
7195. FOOTSTOOLS, F. Garner, London.
7196. AUTOMATIC BRAKE, J. Y. Johnson.—(*E. V. V. de P. Desdouits, France.*)
7197. GAS REGULATOR, J. Stott, London.
7198. HOT-AIR ENGINE, T. Veasey.—(*J. H. Lancaster, United States.*)
7199. BLEACHING POWDER, J. Brock and T. Minton, Widnes.
7200. PULVERISING MILLS, W. H. Coward, Bath.
7201. REPRESENTATIONS of HUMAN BEINGS, H. W. Tullberg, London.
7202. REVERBERATORY FURNACES, A. M. Clark.—(*M. M. Bair, France.*)
7203. CALENDARS for SHOWING DAYS of the WEEK, &c., F. Loos, London.

31st May, 1886.

7204. SECURING ELASTIC TIRES in WHEEL RIMS, E. C. F. Otto, London.
7205. FIRE-ARMS, H. Parsons, Birmingham.
7206. BREAKDOWN GUNS, F. Beesley, London.
7207. CLEANING BOTTLES, H. M. Hansen, London.
7208. SEWING MACHINES, W. Beecroft, London.
7209. PLAYING upon VIOLIN and VIOLONCELLO from PIANOFORTE KEYBOARD, W. B. Wood, Horley.
7210. CLEANING DRAWING ROLLERS of MULES, G. Hudson and J. T. Dawson, Adwalton.
7211. EARS of BUCKETS, C. S. Brand and W. H. Harper, Birmingham.
7212. LIFTING FURNITURE, &c., from WINDOWS, &c., Z. Cheshire, Boston.
7213. CONNECTING the TUBES of BOILERS, H. Lane and R. H. Taunton, London.
7214. MANUFACTURE of KERAMIC TESSERAE, F. Gibbons, Brockmoor.
7215. CONNECTING TAPS with LEAD, &c., TUBES, H. S. Holgate, Manchester.
7216. POWER LOOMS for WEAVING, J. Knowles, Blackburn.
7217. AUTOMATIC APPARATUS for PREVENTING BACKLASH, G. Hind, Hull.
7218. REVOLVING CHAIR for OBVIATING the DANGER of CLEANING, &c., WINDOWS, F. H. Trow, Gloucester.
7219. SPINNING, &c., MACHINERY, J. W. Midgley, Skipton-in-Craven.
7220. BISCUIT BOXES, J. Pinder, Sheffield.
7221. APPLYING NON-CONDUCTORS of HEAT to HANDLES of TEA-POTS, &c., A. Worrall, Sheffield.
7222. HEATING and VENTILATING APARTMENTS, W. H. White, Sheffield.
7223. BRAKE APPARATUS, &c., for TRAMCARS, F. Shorten.—(*O. Kunert, Germany.*)
7224. FIRE ESCAPE APPARATUS, W. J. Cordner, London.
7225. SAFETY ANGLE SHEATH, J. Weston and C. Robinson, Henfield.
7226. AUTOMATIC SPRINKLERS, &c., J. H. Lynde, Manchester.
7227. AUTOMATIC SPRINKLERS, &c., J. H. Lynde, Manchester.
7228. GAS RETORT FURNACES, E. J. Barnfield, Halifax.
7229. TRAMWAY and TRACTION LOCOMOTIVES, J. Magee, Glasgow.
7230. MANIFOLD COPIES of LETTERPRESS and other PRINTED MATTER, T. Batty, London.
7231. PEN, J. W. Major, Exeter.
7232. HOPPER VENTILATORS, E. Hatton, Manchester.
7233. BLOWING GLASS, &c., R. E. Donovan, F. Hazlett, and A. Ross, Dublin.
7234. DRIVING CHAIN, W. Morgan, Birmingham.
7235. IMPROVING the APPEARANCE, &c., of BARLEY, R. Murrell, London.
7236. TAPPETS employed in LOOMS for WEAVING, M. Leach, J. Heaton, and J. Bentley, Bradford.
7237. PRINTING with ENGRAVED ROLLERS, J. Wilkinson and H. Bateson, Lancaster.
7238. HOLDERS for RAILWAY, &c., TICKETS, A. Anderson and G. Whyte, Elgin.
7239. BOLTS, B. G. Martin, Cork.
7240. BUTTON-HOLE SEWING MACHINES, G. Browning, Widnes.
7241. LAWN-TENNIS MARKER, J. Bamford, Lichfield.
7242. AUTOMATIC FEEDING MOTION, N. N. Haigh, Manchester.
7243. COMBINED FLUID MOTIVE-POWER and HAND STEERING GEAR, C. Henderson, Glasgow.
7244. MACHINES for WINDING YARNS, B. A. Dobson, Manchester.
7245. LOCKING DEVICE for NUTS of FISH PLATE BOLTS, T. P. Carswell, London.
7246. FOUR-WHEELED PERAMBULATORS, W. A. Hooton, London.
7247. TIGHTENING, &c., SPOKES of BICYCLE WHEELS, E. Baguley, Newcastle-upon-Tyne.
7248. CHAIRS, W. Okell, Liverpool.
7249. RISING ADJUSTABLE SWIVEL SEAT, A. Dougill, Leeds.
7250. MODIFYING the FLOW of FRESH AIR into ROOMS, H. T. Johnson and T. S. Wilson, Manchester.
7251. MANUFACTURE of CARBON FILAMENTS, W. Maxwell, London.
7252. SPEED-CONTROLLING SPRING REGULATORS, G. Fecker and H. Boecker, London.
7253. MIDDLINGS PURIFYERS, G. Daverio, London.
7254. EMBROIDERING APPARATUS, J. W. von Pittler, Leipsic.
7255. TEAPOTS, &c., W. H. Wood, W. H. Wood, jun, and L. Dolan, Birmingham.
7256. DOLLY PEGS and DOLLIES, C. Yates, Derby.
7257. BOTTLES to CONTAIN FERMENTED LIQUIDS, T. Thompson, Blackpool.
7258. HYDRAULIC MAINS for GAS WORKS, R. Good, London.
7259. GUN MOUNTINGS for DISAPPEARING GUNS, A. Noble, Newcastle-on-Tyne.
7260. CHAIN HARROWS, C. Clay, London.
7261. SELF-LOADING TROLLEY, &c., G. C. Meynell, London.
7262. HOT AIR ENGINES, A. Koerber, London.
7263. TUBES, D. Jones and J. Brunt, Birmingham.
7264. STOPPING ENGINES, J. Fothergill, and W. and I. Briggs, jun., Birmingham.
7265. BATH-BOILERS, E. Hadley and C. Darrah, London,
7266. METALLIC RECEPTACLES for CONTAINING, &c., HYDROCARBONS, C. Darrah, London.
7267. MATTRESSES, T. Löhler, London.
7268. PREVENTING the DESTRUCTION of WATER HEATING APPARATUS by BURNING, J. Winterflood, London.
7269. FEEDING TUBE with COLLAR for CALVES, &c., W. H. Pool, London.
7270. COMBINED DYNAMO-ELECTRIC MACHINE and MOTOR, P. W. Willans, London.
7271. MOTIVE POWER ENGINES, F. Tentschert and C. Sarg, London.
7272. COPYING PRESS, G. Sonnenthal and W. Martin, London.
7273. BATS for CRICKET, &c., H. Richardson, London.
7274. CONTINUITY SYSTEM of TANNING, T. Brain, London.
7275. PIANOFORTES, L. Römhildt, London.
7276. AERIAL NAVIGATION, E. Green, London.
7277. DYNAMO-ELECTRIC MACHINES, A. Le N. Foster and F. V. Andersen, London.
7278. TREATING VEGETABLE TEXTILE MATERIALS, F. Mollet-Fontaine, London.
7279. REGULATOR for HIGH TENSION ELECTRIC CURRENTS, A. H. Byng, London.
7280. MOUNTING HANDLE BARS on BICYCLES, J. Devey, London.
7281. CANDLESTICKS, J. Marston and J. Bowers, London.
7282. PNEUMATIC DOOR CHECKS, J. H. Jefferies, London.
7283. PRODUCTION of MIXED AZO COLOURS, C. A. Martius, London.
7284. PRODUCTION of AZO COLOURS, C. A. Martius, London.
7285. TREATMENT of SLATE, &c., J. B. F. Frédureau, London.
7286. IMPREGNATING AIR with HYDROCARBON VAPOUR, C. D. Abel.—(*G. Daimler, Germany.*)
7287. AUTOMATIC DELIVERY of CIGARS, &c., E. Russ, London.
7288. STOPPING LEAKS of SHIPS, &c., H. H. O. Johow, London.
7289. MEASURING HEAT, M. Immisch, London.
7290. SAFETY WINDOW SASHES, W. Clarke.—(*R. Clarke, D. McFarlane, and J. G. Darling, Canada.*)
7291. HAND RAKES, S. Burlingham, H. Hailey, and T. West, London.
7292. SASH FASTENER, W. Brenton, London.
7293. BALL BEARINGS for WOODEN WHEELS, J. Hemsworth, Biggleswade.

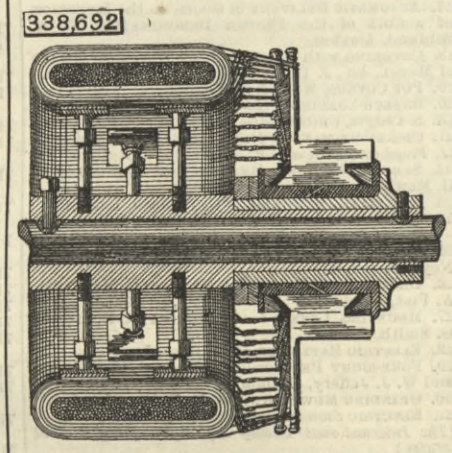
SELECTED AMERICAN PATENTS.

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

338,692. DYNAMO-ELECTRIC MACHINE, *Royal E. Ball, New York, N.Y.—Filed April 25th*, 1885.

Claim.—(1) In a dynamo-electric machine, the combination, with the armature and the shaft, of shoes having grooved faces and screws seated in said shoes and screwing into a sleeve upon said shaft, fibrous packing being interposed between said grooved shoes and the interior of the armature, substantially as described. (2) In a dynamo-electric machine, the combination, with a ring armature, grooved shoes bearing against the same upon the inside, and a fibrous shellac-soaked packing interposed between said armature and shoes, of blocks attached to said shoes, and screw-threaded arms screwing into a sleeve upon said shaft and seated in said blocks, substantially as described.

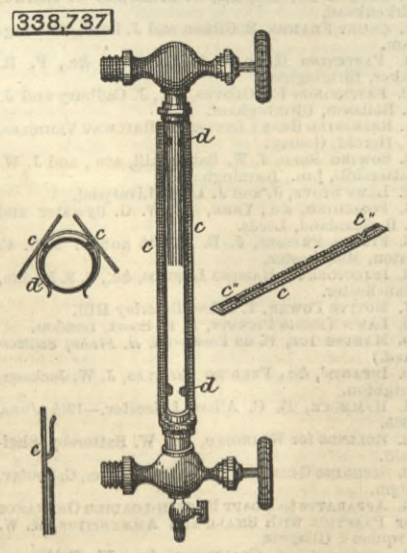
338,692



338,737. WATER GAUGE, *George A. Henderson, Decatur, Ill.—Filed June 15th*, 1885.

Claim.—(1) An opaque partial casing for the glass of water gauges, having an open face and a single longitudinal rearward aperture, as and for the purpose set forth. (2) A glass for water gauges, having one side transparent and exposed and the other side opaquely incased, with the exception of a narrow central longitudinal strip, as and for the purpose set forth. (3) A partial casing for the glass of water gauges, composed of a pair of coextensive opaque strips, longitudinally parallel and laterally adjacent, substantially as and for the purpose set forth. (4) In a casing for the glass of water gauges, for the purpose set forth, the combination of strips *c*, provided with hooks *c''*, and resilient clamps *d*, as shown and described.

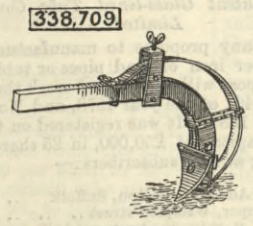
338,737



338,709. CULTIVATOR, *Elisha S. Brown and Charles R. Brown, Santa Rosa, Mo.—Filed December 16th*, 1885.

Claim.—The combination, with a shovel or share, of a beam or shank composed of two parts pivotally united, a bar or leaf spring passing around the rear of and attached at its ends to both parts, but springing away therefrom during the remainder of its length, a yoke secured upon the upper part of the shank or beam, and a set screw seated therein and taking directly upon the spring, substantially as and for the purposes hereinbefore set forth.

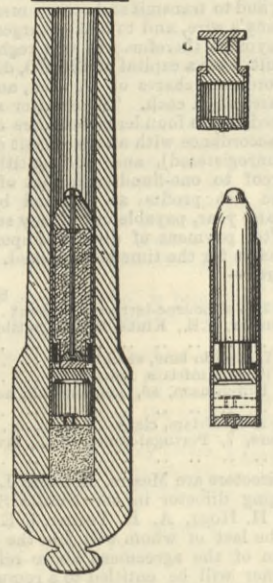
338,709



338,762. SABOT FOR HIGH-EXPLOSIVE PROJECTILES, *Daniel Moore, Brooklyn, N.Y.—Filed June 9th*, 1885.

Claim.—(1) A sabot for projectiles, consisting of an air-tight casing filled with compressed air, and a sliding piston in said casing, said piston being held outward by the compressed air, substantially as described. (2) In combination with the air-tight casing containing compressed air, a sliding piston in said casing, which piston is held outward by the compressed air, and a projectile which enters the casing and bears against the piston, as set forth. (3) In combination with the air-tight casing which has a charging orifice, a stopper covering said orifice, and a sliding piston in the casing, held outward by compressed air, all constituting a sabot, substantially as described.

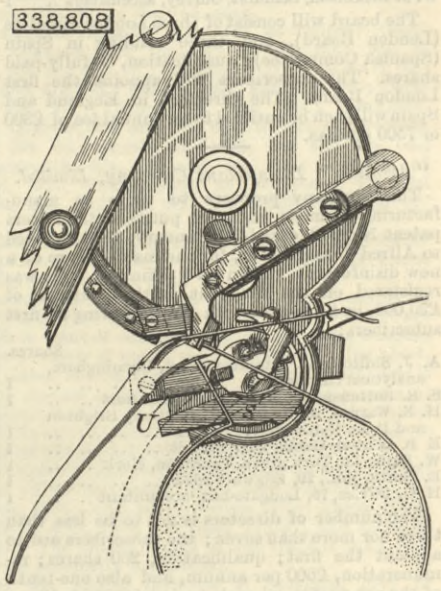
338,762



338,808. SELF-BINDING HARVESTER, *Henry M. Weaver, Mansfield, Ohio.—Filed June 23rd*, 1884.

Claim.—(1) The combination, with a rotary binder arm and a knotter arranged at right angles to the path of the binder arm, of a cord holder and cutter consisting, essentially, of stationary and movable sections or jaws, and a tapering finger forming a continuation of said stationary section or jaw and adapted to catch under the cord as the latter is carried up by the binder arm and deflect it laterally into the jaws of the holder, substantially as set forth. (2) The combination, with a binder arm and a knotter, of a cord holder and cutter consisting, essentially, of a stationary guide hook, slotted as described, and a movable portion, and a tapering finger forming a continuation of the guide hook. (3) The combination with a binder arm and a cord-knotter, arranged at right angles to the path of the binder arm, of a cord holder and cutter consisting, essentially, of a stationary section, slotted as described, and provided with a cord catching and deflecting hook, a movable cutter section adapted to enter the slot in the stationary section, and a movable cord-holding jaw adapted to engage the stationary section, the movable cutter and holder jaws or sections being rigidly secured together, substantially as set forth. (4) The combination with a knotter, of a cord holder consisting, essentially, of a stationary section having a cord catching and deflecting hook, and a movable portion, the latter provided with a laterally extending flange adapted to hold the cord leading from the holder to the binder arm out of the reach of the tying bill. (5) In a tying mechanism for grain binders, the combination, with a cord holder consisting, essentially, of a stationary section having a cord catching and deflecting hook and provided with a laterally projecting flange and a movable section having a laterally projecting flange registering with the flange on the stationary section, of a knotter located adjacent to the cord holder substantially as set forth. (6) The combination with a knotter shaft of a cam loosely encircling said shaft, and devices, substantially as described, for first rotating the cam and shaft simultaneously, and secondly, rotating the shaft and locking the cam. (7) The combination with a knotter shaft having a tying jaw rigidly secured thereto, a movable jaw provided at its inner end with an antifriction roller, and a cam loosely encircling said shaft, of devices, substantially as described, for first rotating the cam and shaft, and secondly, locking the cam substantially as set forth. (8) The combination with a knotter shaft and two pinions of similar construction secured thereon, one rigidly and the other loosely, of the movable jaw of the knotter adapted to engage a cam flange on the loose pinion, and a gear wheel for engaging the pinions, thereby rotating the knotter and operating the jaw substantially as set forth. (9) The combination, with a knotter shaft provided with two pinions of similar construction, one rigidly and the other loosely mounted thereon of the movable jaw of the knotter operated by a cam, on the loose pinion, and a gear wheel adapted to first turn both pinions simultaneously, and secondly turn the fixed pinion and the knotter shaft and lock the loose cam pinion against rotation, substantially as set forth. (10) The combination with a knotter shaft provided with two pinions, one rigidly and the other loosely secured thereon, of the movable jaw of the knotter pivotted thereto and operated by a cam flange on one of the pinions, and a driving wheel adapted to first rotate both pinions simultaneously; secondly, to lock the loose one and rotate the fixed one and the knotter shaft; and thirdly, to lock both, substantially as set forth. (11) The combination with a binder arm and a knotter, of a rigid cord guide partially overlying the knotter, and an outwardly extending flange located outside of the knotter and in close relation to the guide, substantially as and for the purpose set forth. (12) The combination, with a rotary knotter adapted to have two revolutions to tie the knot, of a rigid inwardly inclined cord guide partially overlying the knotter, and constructed to hold the cord out of the reach of the knotter during the first part of its first revolution, and to prevent the cord from slipping off the ends of the jaws as the latter pass under the guide during the latter part of the first revolution and the commencement of the second revolution, substantially as set forth. (13) In tying mechanism for grain binders, the combination, with a knotter shaft carrying a stationary and a pivotted jaw, a sleeve surrounding said shaft and having a cam adapted to be engaged by the inner end of the pivotted jaw, and devices for rotating said cam sleeve, of a stationary cam flange for holding the pivotted jaw in a closed position and the yielding spring cam for yieldingly holding the pivotted jaw in a closed position, substantially as set forth. (14) The combination with a knotter shaft having a rigid jaw and a pivotted jaw, of the flange S, partially surrounding the knotter and having a cam thereon for holding the jaws in closed adjustment. (15) The combination with a knotter shaft having a rigid jaw and a pivotted jaw, of the flange S, partially surrounding the knotter and having a cam thereon for holding the jaws in closed adjustment, and the yielding spring cam U, forming a continuation of said flange, substantially as set forth. (16) The combination with a knotter shaft having a rigid jaw and a pivotted jaw, a sleeve encircling said shaft and provided with a cam and gearing, substantially as described, for operating said shaft and sleeve, of the flange S, partially surrounding the knotter and having a cam thereon, all of the above parts combined and operating substantially as described. (17) The combination with a knotter shaft, having a rigid jaw and a pivotted jaw, a sleeve encircling said shaft and provided with a cam and gearing, substantially as described for rotating the shaft and sleeve, of the flange S, partially surrounding the knotter and having a cam thereon, and the yielding spring cam U, forming a continuation of said flange, substantially as set forth.

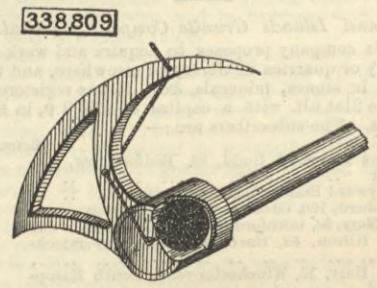
338,808



338,809. SELF-BINDING HARVESTER, *Henry M Weaver, Mansfield, Ohio.— Filed August 23rd*, 1884.

Claim.—(1) The combination with a binder arm of a cord receptacle located within said arm, substantially as set forth. (2) The combination with a binder arm of a cord receptacle located within the hub of said arm, substantially as set forth. (3) The combination with a revolving binder arm of a cord receptacle located within said arm and caused to rotate therewith, substantially as set forth.

338,809



338,827. SAFETY-VALVE, *Joseph M. Coale, Baltimore, Md.—Filed January 2nd*, 1886.

Claim.—(1) The combination, with the main valve A, the seat *a* therefor, and the auxiliary valve B and its co-operating lip or seat W, of a sinuous steam passage, *b*, terminating in an inclined upchute, decreasing in size toward its outer end, said passage intervening between the main valve and its seat on the one hand and the auxiliary valve and its seat or co-operating lip on the other hand, substantially as and for the purposes hereinbefore set forth. (2) The combination of the valve proper, the seat therefor, the escape or blow-off passage M, the guide cylinder, the guide head or flange arranged above and connected to the valve substantially in the manner described, so that there shall be between the two a space that is in communication with the blow-off M, and the packing or guide ring carried by said head and fitting and movable up and down in said cylinder, substantially as and for the purposes hereinbefore set forth. (3) The valve proper, the seat therefor, the spindle E, provided with head E' and stepped in the valve, the blow-off passage M, communicating with the space between the head E' and the valve, the spring case G, and the packing or guide ring *e*, mounted and laterally movable on the head E' and fitting and adapted to move up and down in the spring case G, as and for the purposes hereinbefore set forth.

338,827