ON THE CALCULATION OF FRAMEWORKS WITH SUPERFLUOUS PARTS.

By MAX AM ENDE.

(Concluded from page 90.)

ACCORDING to the *principle of work* as stated previously, *the work of the internal forces in an elastic framework is equal to the work of the external forces.* If $F_1, F_2, F_3, \ldots$ are external forces; $f_1, f_2, f_3, \ldots$ the movements of their points of application; $S_1, S_2, S_3, \ldots$ the stresses in the bars of the framework; and $\Delta l_1, \Delta l_2, \Delta l_3, \ldots$ their elongations, then the work will be:

$$W = \tfrac{1}{2} \Sigma F f = \tfrac{1}{2} \Sigma S \Delta l \quad \ldots \ldots \quad (10)$$

If then the former symbols for the stresses and elongations of the necessary and in the superfluous bars are used again, we have for the internal work the equation:

$$2 W = S' \Delta l' + S'' \Delta l'' + S \Delta l''' \ldots + S_1 \Delta l_1 + S_2 \Delta l_2 + S_3 \Delta l_3 + \ldots \quad (11)$$

$$S_1 = R_1 + \sigma'_1 S' + \sigma''_1 S'' + \sigma'''_1 S''' + \ldots$$
$$\text{and } \Delta l_1 = S_1 m_1$$
$$S_2 = R_2 + \sigma'_2 S' + \sigma''_2 S'' + \sigma'''_2 S''' + \ldots$$
$$\text{and } \Delta l_2 = S_2 m_2$$
&c. &c.

Hence:

$$2 W = (S')^2 m' + (S'')^2 m'' + (S''')^2 m''' + \ldots + (R_1 + \sigma'_1 S' + \sigma''_1 S'' + \sigma'''_1 S''' + \ldots)^2 m_1 + (R_2 + \sigma'_2 S' + \sigma''_2 S'' + \sigma'''_3 S''' + \ldots)^2 m_2 + \ldots \quad (12)$$

Differentiating this expression according to S′, S″, S‴ successively we have:

$$\left.\begin{aligned} \frac{d W}{d S'} &= S' m' + \sigma'_1 (R_1 + \sigma'_1 S' + \sigma''_1 S'' + \ldots) m_1 \\ &\quad + \sigma'_2 (R_2 + \sigma'_2 S' + \sigma''_2 S'' + \ldots) m_2 + \ldots \\ \frac{d W}{d S''} &= S'' m'' + \sigma''_1 (R_1 + \sigma'_1 S' + \sigma''_1 S'' + \ldots) m_1 \\ &\quad + \sigma''_2 (R_2 + \sigma'_2 S' + \sigma''_2 S'' + \ldots) m_2 + \ldots \\ &\text{\&c.} \end{aligned}\right\} (13)$$

It will be seen that these are the same expressions as those, which according to equations (6) are = 0. We conclude therefrom that *the work in an elastic framework is a minimum with regard to the stress in any one bar*, or that *in an elastic framework always those stresses occur which produce a minimum of work.* This is Castigliano's theorem.

In Fig. 3 we applied at point K an external force S^k, and found the deflection Δl^k by equation (9). *This deflection in the direction of the force is equal to the differential according to the force of the whole internal work.*

Namely, writing equation (10) as follows:

$$W = \tfrac{1}{2} S^k \Delta l^k = \tfrac{1}{2} (S^k)^2 m^k = \tfrac{1}{2} \Sigma S \Delta l \quad \ldots \quad (14)$$

we have in the last expression the whole internal work. Differentiating according to S^k we have

$$\frac{d W}{d S^k} = S^k m^k (= \Delta l^k) = \frac{d}{d S^k} (\tfrac{1}{2} \Sigma S \Delta l) \quad \ldots \quad (15)$$

which proves the above proposition.

If we write out the expression $\Sigma S \Delta l$ in analogy to (11) and work out the differentiation, we should find the expression which already according to (9) was equal to Δl^k. Both theorems, as shown here, are derived from the principle of work (equation 10). In using them for the calculation of stresses and deflections, we must deduce from them the equations (6) and (9). But it was shown previously that these equations can be deduced direct from the principle of work, or even geometrically without the principle of work; it is therefore not necessary, for practical purposes, to resort, as some do, to these theorems.

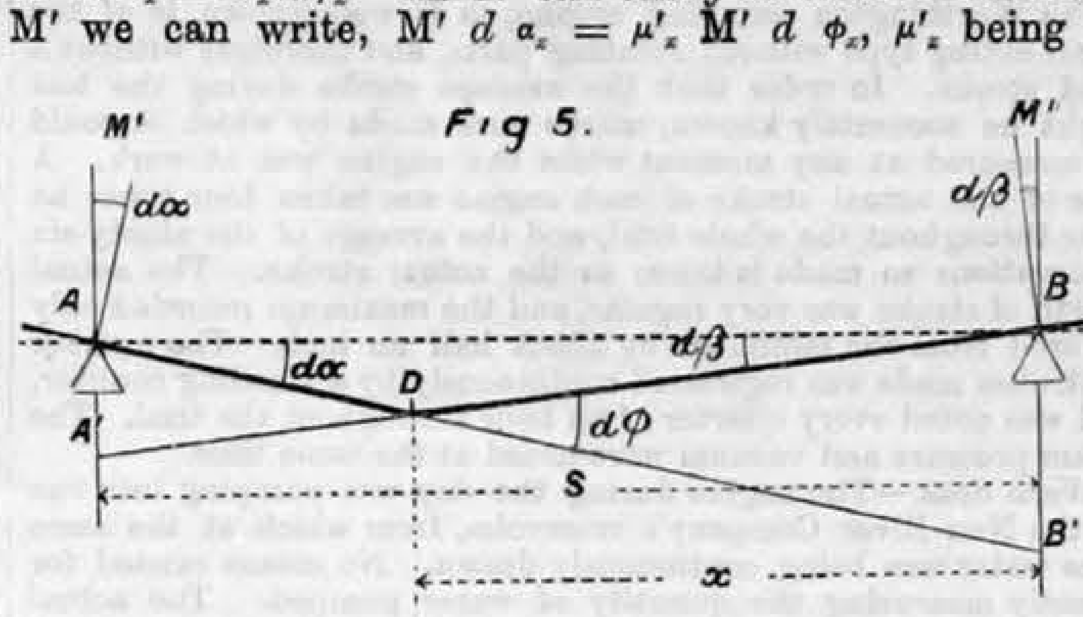
FRAMEWORKS WITH SOLID WEBS.

Instead of dealing with bars of the length l, and measuring their elongations Δl, we deal here with pieces enclosed by two imaginary parallel planes at the small distance Δs from each other, and measure the angle $d \phi$ formed between the planes in consequence of a bending moment N in the piece. The planes are at right angles with the neutral axis of the frame, and, as the angles $d \phi$ of a series of adjoining pieces have eventually to be added, the calculation will apply accurately only to frames with a straight neutral axis or approximately to such, where its curvature is large compared with the depth of the frame. Work is here $\frac{N d \phi}{2}$, where $d \phi$ is measured by the length of the arc at the radius = 1. The moment may be either thought of as a couple of forces or as an infinitesimal force at an infinite distance. If the moment is caused by one finite force S at a finite distance, and at a given angle A with the planes, the work will be increased by first, the work which the component of the force at right angles to the planes does in extending or compressing the piece Δx and second, by the work which the component parallel with the planes does in shifting them parallel with each other by the distance $d \eta$. The first increase is $\frac{(S \text{ sine } A)^2 \Delta x}{2 a E}$ where a is the sectional area of the piece in the planes, and the second increase is $\frac{(S \cos A)^2 \Delta x}{2 a G}$, where G, the modulus for elastic shearing, is generally smaller than E.

THE STRAIGHT BEAM.

Let A B, Fig. 5, be the neutral fibre of a straight solid beam or plate girder; let Δx, a small piece between two parallel planes at right angles with it, be invested with the bending moment N_x from any cause, then, assuming that Δx is the only flexible piece in the beam, its neutral fibre will assume the form A D B, so that $\angle$ A D B = 180 deg. $- d \phi_x$, and the work in Δx will be $\frac{N_x d \phi_x}{2}$. If the cause of N_x is a moment M′ at A, and if a sectional plane at A has turned through an angle $d \alpha_x$, we have according to the principle of work: $M' d \alpha_x = N_x d \phi_x$. As N can easily be determined from M′ we can write, $M' d \alpha_x = \mu'_x M' d \phi_x$, μ'_x being a number corresponding to σ'_x in the first part of this paper. Dividing by M′ we have:—

Fig 5.



$$d \alpha_x = \mu'_x d \phi_x \quad \ldots \ldots \quad (16)$$

This equation shows that the relation between $d \alpha$, $d \beta$, and $d \phi$ is independent of the cause of the flexure $d \phi$. For example, if in addition to the moment M′ a moment M″ acted at B or moments and forces acted between A B on the beam, that relation would remain unaltered.

In the same way we find

$$d \beta_x = \mu''_x d \phi_x \quad \ldots \ldots \quad (16a)$$

The equations might have been found geometrically, only considering that the effect of M'_x upon the beam decreases gradually from A to nil at B and *vice versâ*, the effect of M″ from B to A. Namely we have:—

$$\left.\begin{aligned} B B' &= x \tan d \phi_x = s \tan \alpha_x \\ A A' &= (s - x) \tan d \phi_x = s \tan \beta_x \end{aligned}\right\} \quad \ldots \quad (17)$$

Considering that the tangents of small angles are equal to the angles themselves, and putting μ'_x for $\frac{x}{s}$ and $\mu''_x = \frac{s - x}{x}$, we obtain equations (16).

Regarding now N_x as the moment from all causes at Δx we have:

$$N_x = R_x + \mu'_x M' + \mu''_x M'' \quad \ldots \ldots \quad (18)$$

where R_x are moments caused by forces or moments acting at points between A and B. Further we know that $d \phi_x = \frac{N_x \Delta x}{E J_x}$, where J_x is the moment of inertia of the section of the beam at Δx. Putting here for N_x its value and then $d \phi_x$ into (16), and letting all pieces Δx be flexible, we have:

$$\left.\begin{aligned} \Delta \alpha &= \Sigma_0^s \frac{\mu'_x}{E J} (R_x + \mu'_x M' + \mu''_x M'') \Delta x \\ \Delta \beta &= \Sigma_0^s \frac{\mu''_x}{E J} (R_x + \mu'_x M' + \mu''_x M'') \Delta x \end{aligned}\right\} \quad . \quad (19)$$

If some of the forces and moments causing R_x are unknown quantities, as in the case of intermediate supports between A and B, R_x will be dissolved into $R_{(x)} + \mu'''_x M''' + \mu''''_x M'''' +$ &c., and more equations would be added to (19) embodying the elastic conditions of those supports under the reactions of the beam. In this way girders continuous over several supports may be calculated, but the process would be somewhat complicated. Here it is preferable to follow Clapeyron's method of considering each span independently, and using the angles $\Delta \alpha$ and $\Delta \beta$, which occur again in the two adjoining spans, as auxiliary unknown quantities. In this case the moments R_x are known quantities.

If the beam A B is loaded with the uniform load p per unit of length we have $R_x = \frac{p\, x\, (s - x)}{2}$. Putting this with $\mu'_x = \frac{x}{s}$ and $\mu''_x = \frac{s - x}{s}$ into (19) and reducing the small length Δx to the infinitesimal length $d x$ we have:

$$\Delta \alpha = \int_0^s \frac{x}{s E J} \left(\frac{p\, x\, (s - x)}{2} + \frac{x}{s} M' + \frac{s - x}{s} M'' \right) d x$$

$$\Delta \beta = \int_0^s \frac{s - x}{s E J} \left(\frac{p\, x\, (s - x)}{2} + \frac{x}{s} M' + \frac{s - x}{s} M'' \right) d x$$

Working out, we find:

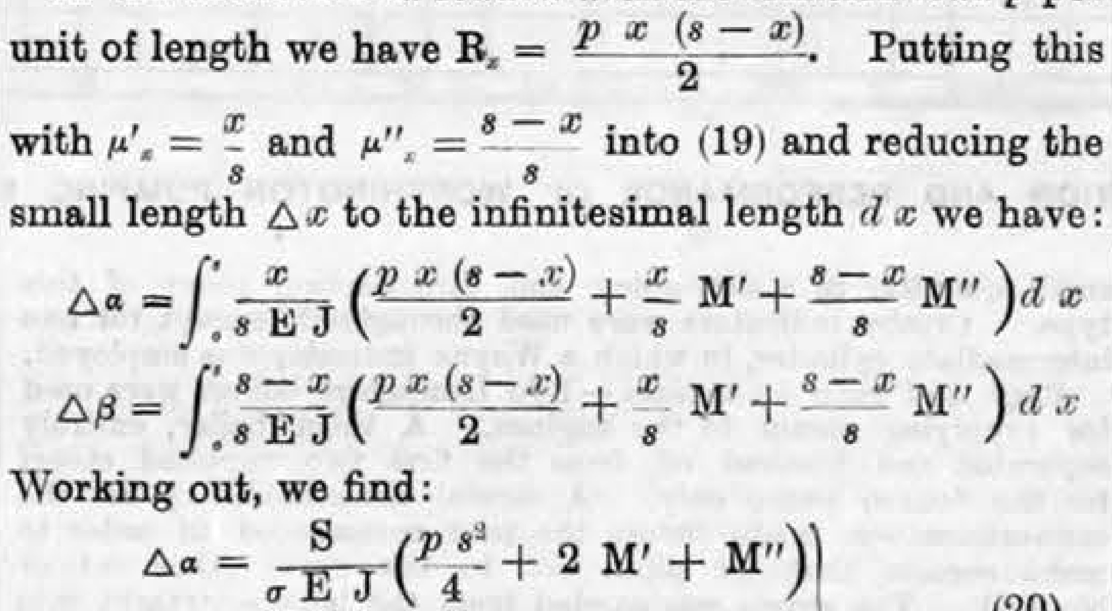
$$\left.\begin{aligned} \Delta \alpha &= \frac{S}{\sigma E J} \left(\frac{p\, s^2}{4} + 2 M' + M'' \right) \\ \Delta \beta &= \frac{S}{\sigma E J} \left(\frac{p\, s^2}{4} + M' + 2 M'' \right) \end{aligned}\right\} \quad . \quad . \quad (20)$$

which are the well-known equations of Clapeyron.

THE CURVED BEAM.

Let A D B—Fig. 6—be the neutral fibre of a thin

Fig 6.



curved beam resting on the pivot bearings A and B, of which the latter is movable without friction in the direction A B. Let Δl be the length of a small piece at D, which lies at the distance x from the vertical through B, and let this be the only flexible piece in the curved beam. Then we can replace the two curved pieces by the straight pieces A D and D B for the purpose of observing better the elastic deformation of the beam. Let M′ be a bending moment applied at A, producing at D a bending moment $\mu'_x M'$, in consequence of which the angle ϕ_x at D is altered by $d \phi_x$, and the beam deflects into the position A D′ B′. At the same time the angle α at A is altered by $d \alpha_x$, and the angle β at B by $d \beta_x$. Then, assuming these alterations to be very small, we have, according to the principle of work: $M' d \alpha_x = \mu'_x M' d \phi_x$, or

$$d \alpha_x = \mu'_x d \phi_x \quad \ldots \ldots \quad (21a)$$

In the same way, if a moment M″ were applied at B we should have: $M'' d \beta_x = \mu''_x M'' d \phi_x$, or

$$d \beta = \mu''_x d \phi_x \quad \ldots \ldots \quad (21b)$$

Considering that $\mu'_x = \frac{x}{s}$ and $\mu''_x = \frac{s - x}{s}$, it will be seen that the above equations might have been deduced purely geometrically and independently of the values of the moments M′ and M″, and that the amount of the alterations of the three angles, but not their relation towards each other, depends upon the bending moment N at D, from whatever cause it may be derived.

Bearing still in mind that the alterations of the angles α, β, ϕ are very small, and disregarding the deformation due to axial compression and to shearing, we have further the equation

$$d s = y\, d \phi_x \quad \ldots \ldots \quad (21c)$$

If all the pieces of the beam are flexible we have

$$\left.\begin{aligned} \Delta \alpha &= \int_0^s \mu'_x\, d \phi_x \\ \Delta \beta &= \int_0^s \mu''_x\, d \phi_x \\ \Delta s &= \int_0^s y\, d \phi_x \end{aligned}\right\} \quad \ldots \ldots \quad (22)$$

Here we put as before $d \phi_x = \frac{N_x d l_x}{E J_x}$ and for N_x its value from all causes. These causes may be loads producing the moments R_x, an abutment reaction H in the direction A B causing Δs to become nil and the moments M′ and M″, so that

$$N_x = R_x + H y + \mu'_x M' + \mu''_x M''.$$

Then we have

$$\left.\begin{aligned} \Delta \alpha &= \int_0^s \mu'_x (R_x + H y + \mu'_x M' + \mu''_x M'') \frac{d l_x}{E J_x} \\ \Delta \beta &= \int_0^s \mu''_x (R_x + H y + \mu'_x M' + \mu''_x M'') \frac{d l_x}{E J_x} \\ \Delta s &= \int_0^s y (R_x + H y + \mu'_x M' + \mu''_x M'') \frac{d l_x}{E J_x} \end{aligned}\right\} \quad (23)$$

These equations contain the six unknown quantities $\Delta \alpha$, $\Delta \beta$, Δs, H, M′, and M″, and if any three of them are given the other three can be calculated, for example:—

(1) Given H = 0, M′ = 0, M″ = 0, we can calculate the alteration of the angles α and β, and the movement Δs of a curved beam.

(2) Given M′ = 0, M″ = 0, and $\Delta s = 0$, we can calculate the horizontal abutment reaction and the alterations of the angles α and β of an arch with pivots at its two abutments.

(3) Given $\Delta \alpha = 0$, $\Delta \beta = 0$, $\Delta s = 0$, we can calculate the horizontal abutment reaction and the moments at A and B of an arch fixed at the abutments, and these being found we can calculate the stresses in the arch.

As superfluous parts may in the latter case be regarded (1) the abutment A in its capacity to resist the turning action of M′; (2) the abutment B in that of resisting the turning action of M″; (3) the same abutment in that of resisting the sliding action of H. Assuming that the coefficients of these resistances can be ascertained, and naming them m', m'', and m''' respectively, we have $M' m' = \Delta \alpha$, $M'' m'' = \Delta \beta$, and $H m''' = \Delta s$. Considering that these movements take place in the opposite direction, to the resisting actions upon the arch, and putting their values into (23), we obtain equations entirely of the form of equations (6).

If it is desired to take into account the effect of the compression of the neutral axis of the arch, as well as of its deformation from the shearing forces, it will be seen that only the third of the equations (23) is affected. Naming g the angle, which the small piece $d l_x$ forms with the horizontal, P the axial pressure, and S the shearing force, we have to add to the expression for Δs in (23) the members $\int_0^s P \cos \gamma \frac{d l_x}{a E}$ and $\int_0^s S \sin \gamma \frac{d l_x}{a G}$, where a is the sectional area of the piece $d l_x$, and G the modulus of shearing elasticity. P and S can be stated in terms of M′, M″, and H, but it is better to introduce these terms, when the form of the arch and the load is given, than to attempt to do so in the general equation.

REPORT ON A PUMPING ENGINE AT HORNSEY SLUICE.

APPENDED we give the results of a trial recently carried out by Professor Kennedy on the feed consumption of a triple expansion high-duty Worthington pumping engine, recently erected at Hornsey Sluice for the New River Waterworks Company by the well-known makers, Messrs. James Simpson and Co., of Grosvenor-road, London, who designed the engine in conjunction with Mr. E. L. Morris, the engineer to the New River Waterworks Company, and on page 140 we give an illustration showing a general side elevation view of the pumping engine in question. The engine is designed to work with a steam pressure of about 130 per square inch, and on inspection of the indicator diagrams, p. 140, it will be noticed that the initial pressure in the high-pressure cylinder very nearly reaches this point. The speed and stroke of this engine is varied by adjusting the cut-off gear, combined with any alteration of pressure in the air chamber of the high-duty attachment. Certain details of the general arrangement are given in Professor Kennedy's report, and it will be noticed on referring to the drawing that all the steam and cut-off valves are of the Corliss type, and are placed directly below the cylinders, thus effectually draining them. All the cut-off valves for both sides of the engine are adjustable by hand-wheels on one side only of the engine, and can be altered whilst the engine is moving; this arrangement enables the engine to be easily handled, and in a large engine of this class is a decided advantage. The main valve gear levers are of steel, and the air and feed pumps are driven from them. These pumps are placed below the surface condenser, through which the suction water passes to the main pumps. The compensating gear is fixed between the high-pressure cylinders and the main pumps; the air pressure and feed supply pumps for supplying the compensating cylinders are driven off the main journals in the usual manner; the compensators work as a rule with a pressure of 250 lb. per square inch. The entire engine is finished in very first-class style and lagged with mahogany and brass bands, and the successful results which have been obtained from this plant must be most gratifying to the Waterworks Company and the builders, Messrs. J. Simpson and Co., and undoubtedly a large saving of fuel will result from the very economical working of this engine. This engine is the second Worthington engine which has been built for the New River Waterworks Company, the first having been erected at Green Lanes, Finsbury, in 1888, where it has been at constant work ever since and giving the greatest satisfaction. One cannot help noticing what improvement in general design has been made with this class of engine since it was first introduced into this country in 1886, and the fact that over 200 engines have now been built by Messrs. James Simpson and Co. points to the very good results that have been attained by their adoption. The largest engine yet built has been recently shipped to Calcutta, and is of some 550-horse power, having a 5ft. stroke, and they have one of 400-horse power now on hand for one of the large London water companies.

The two sewerage engines, each of 18 millions capacity, recently made for the London County Council at Abbey Mills, are two of the best examples of that class; in fact, the uniform flow from the Worthington type of engine renders it the best that can be used for all kinds of pumping. In Professor Kennedy's report which follows attention should be drawn to the low figure of coal consumption, namely, 1·34 lb. per indicated horse-power per hour, which, with the mechanical efficiency of the engine taken at 84·4 per cent., is equivalent to 1·59 lb. per horse-power in water actually lifted, the steam consumption per hour per indicated horse-power being 14·2 lb. During the trial the engine was kept at a mean speed of 25·2 double strokes per minute. It will be seen on reference to the diagram that the supply of coal and feed was maintained very constantly and the lines kept nearly parallel. The report appended is very full and gives all further details of this trial:—

Report on the Efficiency and Water Consumption of a Pumping Engine at Hornsey Sluice.

Messrs. James Simpson and Co., Ltd.,
101, Grosvenor-road,
Pimlico, London, S.W.

Dear Sirs,—I have pleasure in reporting to you the results of a trial which I have carried out with one of your engines, on the 24th of July last, in accordance with instructions received from you. The main object of the trial was the determination of the weight of steam used per horse-power, and of the efficiency of the plant. Incidentally measurements were also made of the amount of coal used.

Engine.—The engine tested is a triple-expansion surface-condensing high-duty Worthington pumping engine constructed by your firm, and now at work at the New River Company's pumping station, Hornsey Sluice. It has cylinders nominally of 16in., 25in., and 42in. diameter. The three cylinders of each engine are in tandem with each other, and with a double-acting ram pump, having a diameter of 17·5in. The nominal full stroke of the whole is 3ft. 6in. After the trial was over all the covers were removed, and the diameters of the cylinders and plungers, as well as of the rods, carefully measured. The exact diameters so obtained, which differ very slightly from the nominal dimensions, are given in the appended table, and have been used in the calculations of power. Each cylinder is fitted with a body jacket, and the passages between each pair of cylinders are also steam jacketed, so as to form, in fact, reheaters.

The Worthington pumping engine, as is well known, is of the direct-acting type without rotating parts, and therefore without a fixed stroke. In order that the average stroke during the test might be accurately known, marks were made by which it could be measured at any moment while the engine was at work. A note of the actual stroke of each engine was taken four times an hour throughout the whole trial, and the average of the ninety-six observations so made is taken as the actual stroke. The actual length of stroke was very regular, and the maximum recorded only differed from the minimum by about half an inch. The number of strokes made was registered continuously by a Harding counter, and was noted every quarter of an hour throughout the trial. The steam pressure and vacuum were noted at the same time.

Work done.—The engine during the day was pumping into one of the New River Company's reservoirs, from which at the same time water was being continuously drawn. No means existed for directly measuring the quantity of water pumped. The actual head of water against which the pumping took place was read upon a water-gauge in the engine-room, this gauge being afterwards tested against a mercury column. The depth of suction below the floor of the engine-room was read every quarter of an hour during the trial, and has been allowed for, along with the height of the pressure-gauge above the engine-room floor. The quantity of water pumped, and the figures as to pump horse-power given below, must be taken as corresponding simply to the measured head and measured dimensions of the pump, assumed to be filled throughout at every stroke, and to have no slip. There can be no doubt that the slip, if any, is a very small quantity in a slow-going and direct-acting pump of this type. Crosby indicators were used throughout, except for one intermediate cylinder, in which a Wayne indicator was employed.

Steam and water connections.—Two Lancashire boilers were used for supplying steam to the engines. A third boiler, entirely separated and blanked off from the first two, supplied steam for the donkey pump only. A careful examination of all the connections was made before the trial commenced in order to make certain that all pipes not in use were either cut or blanked. The steam was carried from the boilers straight into the engine-room to a centrifugal separator placed above the high-pressure cylinders. This separator was kept drained through a cock into a pail, and the drainage weighed every hour. All the cylinder jackets were supplied with live steam of boiler pressure from above the separator. The drains from the jackets, as well as from the intermediate heaters placed between each pair of cylinders, were taken to a water-sack standing in the pit below the engines. This water-sack was fitted with a glass gauge, which allowed the rate at which it filled up to be determined, and in this way seven determinations were made of the total quantity of water discharged from the jackets and reheaters. The hot water discharged from the water-sack was finally mixed with the air pump discharge in the hot well.

The condenser used for the engine is a tubular surface condenser, and the whole of the water pumped passes through it.

The engine feed pumps, which under ordinary circumstances pump direct to the boiler, were on the trial used to pump the hot well discharge—with which, as has been said, the jacket water was mixed, and to which any necessary supplementary feed was added—into a tank in the engine-room raised about 12ft. from the floor. The discharge from the pumps into this tank was throttled, so that the pumps might work approximately against the pressure at which they would have worked if they had been delivering into the boilers as usual. Below the top tank were two measuring tanks, containing 1246 lb. and 1325 lb. of water respectively up to the marks used. These were filled and emptied alternately, the water from them falling into a sump tank placed below them, from which the donkey pump drew the feed.

In this way the water was measured into the boilers, and the total quantity so measured was the total quantity evaporated by the boilers, which were working so easily that it was unnecessary to measure for priming. The total steam received by the engines was equal to the total water as measured, minus the quantity of water drained from the separator. It includes the whole of the steam which went to the jackets and to the reheaters.

Boilers.—The two boilers used for supplying the steam to the engine were of the Lancashire type, 7ft. 6in. diameter and 30ft. long, each having two furnaces, 3ft. internal diameter. The grate surface of each boiler was 29·2 square feet, and the heating surface of each boiler 960 square feet. The nominal boiler pressure was from 125 lb. to 130 lb. per square inch. The pressure was kept very steady throughout the whole day, and the boiler level was also kept extremely steady. The stoking was in the hands of the ordinary stoker, and was exceedingly good. The coal, however, was of a special quality, obtained for the trial in order that its results might be the more easily compared with those obtained in other boiler trials under standard conditions. The coal used was Nixon's Navigation hand-picked, and free from small and slate. The calorific value of this fuel was found by experiment to be 14,700 thermal units per pound, so that its theoretical evaporative capacity was 15·21 lb. of steam from and at 212 deg. Fah. The amount of ash in the coal was 3·84 per cent., and of moisture 0·56 per cent.

The coal was weighed on to the stoking floor in lots of 2 cwt. at a time. A running start and finish were made, the pressure and water level being the same in each case, and the fires being of approximately the same thickness according to marks placed upon the fire door. The long duration of the trial practically eliminates any error due to small errors in estimating this matter, and the straightness of the curves also shows that they were negligible. The trial took place on the 24th of July. The engine was started early on that morning, and I started the actual trial at 9 a.m. It ended at nine minutes past 9 p.m., with the boiler levels the same as at the start, with a water tank just finished, and with the steam pressure 2 lb. higher than in the morning. The duration of the trial was thus 12 hours and 9 minutes. The engines and pumps worked during the whole period quite steadily and quietly, without the slightest hitch of any kind whatever. The extreme regularity of all the conditions during twelve hours is very well shown by the somewhat unusual straightness of the lines upon the accompanying diagram.

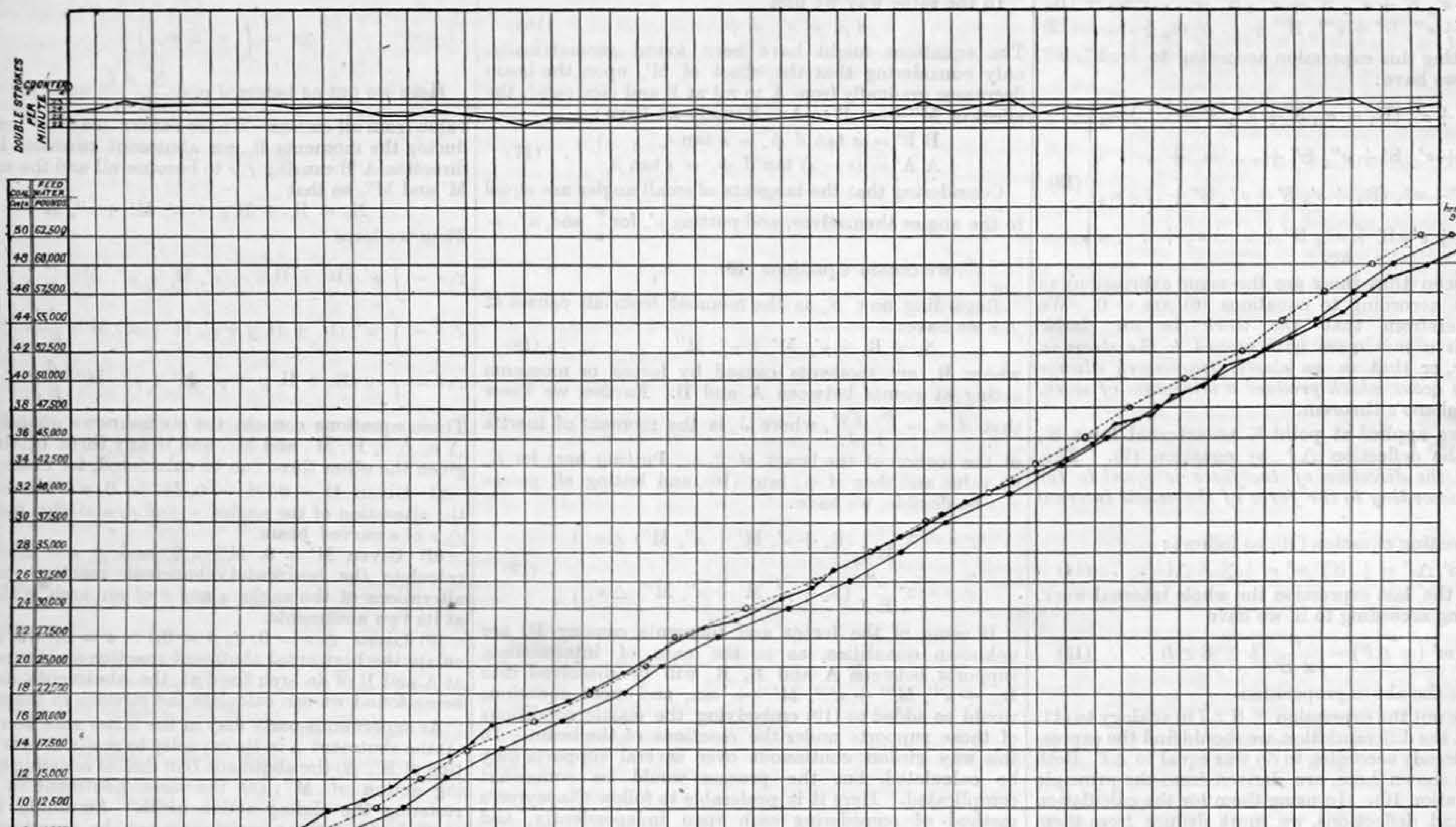


DIAGRAM SHOWING CONSUMPTION AND PERFORMANCE OF WORTHINGTON PUMPING ENGINE AT HORNSEY SLUICE

Coal.—The time of starting and of finishing each lot of weighed coal was noted separately. The total weighed coal used was 5623 lb. Taken from start to finish of a firing, this lasted 703 minutes. Taken from finish to finish, it lasted 719 minutes. Taking the mean of these two as most fairly representing the rate at which the coal was burnt, the time may be taken as 711 minutes, which corresponds to 475 lb. per hour.

Water.—The total amount of water put into the boilers was 61,706 lb. in 729 minutes. This is equivalent to 5079 lb. per hour. During the same time the amount of water taken from the separator averaged 61 lb. per hour, so that the net feed-water going to the engines was 5018 lb. per hour. The total water taken from the jacket and reheater drains, as mentioned above, was 790 lb. per hour approximately. This is 15·8 per cent. of the total steam going to the engines.

Power.—Twenty-three sets of indicator diagrams were taken in all. The first five sets, however, were not satisfactory, owing to one of the indicators sticking, and the mean indicated horse-power has therefore been worked out from the remaining eighteen sets. It will be seen from the diagram that the work altered very little throughout the whole day. The mean indicated horse-power for the eighteen sets of cards was 351·0, and the mean calculated simultaneous pump horse-power was 296·3. The efficiency of the machine—that is, the ratio of pump horse-power to indicated horse-power—is therefore 84·4 per cent. The total weight of water pumped per hour, calculated as mentioned above, was 2,242,000 lb. The mean head, including the suction, was 263·3ft., which corresponds to 114·04 lb. per square inch. From these figures the average pump horse-power during the whole trial works out to 298·2, a figure differing very slightly from that corresponding to the times at which the last eighteen sets of indicator diagrams were taken. The corresponding mean indicated horse-power at 84·4 per cent. efficiency for the whole period of the trial is therefore 353·3.

The mean effective pressure in the engine reduced to the low-pressure piston works out to 22·9 lb. per square inch. The mean speed throughout the whole day was 25·2 double strokes per minute. The mean total head of water, including the suction, was 263·3ft., and the actual mean stroke of the engine 43·5in.

Duty.—The coal per indicated horse-power hour amounts to 1·34 lb., and per pump horse-power hour to 1·59 lb. only, and this corresponds to 12,450 lb. of water raised 100ft. per pound of coal, or otherwise expressed, to the exceptionally high duty of 139,500,000 foot-pounds per cwt.—112 lb.—of coal.

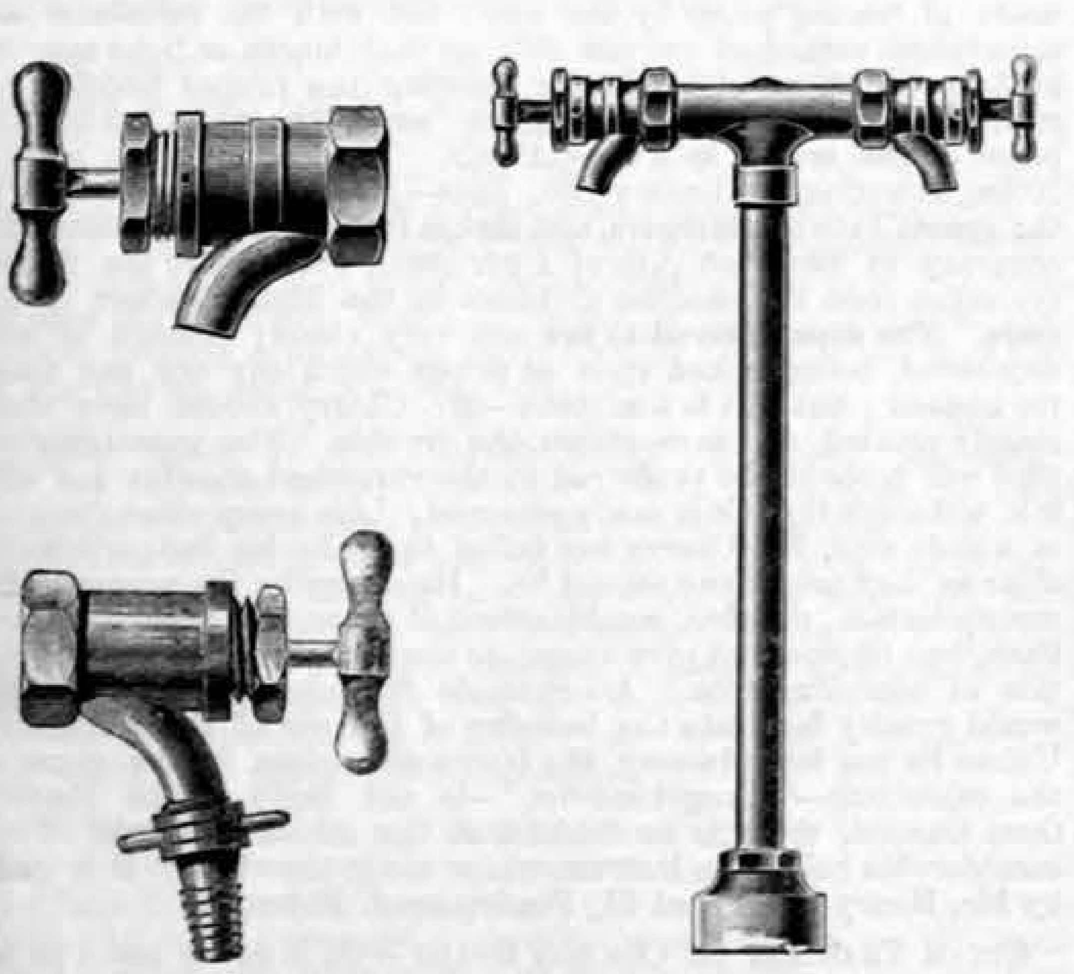
The principal results of the trial are given in the accompanying table, and are shown graphically in the accompanying diagram.—I remain, yours faithfully, ALEX. B. W. KENNEDY.

Pumping Engine at Hornsey Sluice.

Date of trial	July 24th, 1894
Duration of trial (for water measurements)	12 hours 9 minutes
Diameters of cylinders and rods:—	
High-pressure	16·00in. and 3·75in.
Intermediate	25·01in. and 3·25in.
Low-pressure	42·16in. and 2·75in.
Pump plunger	17·51in.
Pump rod (one end only)	3·50in.
Mean stroke of piston	43·5in.
Number of boilers in use	Two
Total length of each boiler	30ft.
Diameter of each boiler	7ft. 6in.
Diameter of furnaces	3ft.
Total heating surface of both boilers	1921 sq. ft.
Total grate surface of both boilers	58·4 sq. ft.
Ratio of heating surface to grate surface	33 : 1
Mean boiler pressure above atmosphere per square inch	127·6 lb.
Mean admission pressure, high-pressure cylinder per square inch	121·5 lb.
Mean effective pressure, high-pressure cylinder, per square inch	48·8 lb.
Mean effective pressure, intermediate cylinder, per square inch	16·5 lb.
Mean effective pressure, low-pressure cylinder, per square inch	10·45 lb.
Total reduced to low-pressure cylinder, per square inch	22·9 lb.
Mean vacuum	14·0 lb.
Double strokes per minute, mean	25·2
Indicated horse-power:—	
High-pressure cylinders	102·8
Intermediate cylinders	87·9
Low-pressure cylinders	160·3
Total	351·0
Indicated horse-power corresponding to pump horse-power over whole trial	353·3
Total water pumped per hour (calculated)	2,242 000 lb.
Mean total head in feet	263·3 lb.
Corresponding pressure, lb. per square inch	114·04 lb.
Mean pump horse-power	298·2
Total feed-water per hour	5079 lb.
Total water taken from separator per hour	61 lb.
Total steam to engines per hour, including jackets	5018 lb.
Total steam per hour in jackets and reheaters	790 lb.
Mean temperature of feed	117·1 deg. Fah.
Coal burnt per hour	475 lb.
Coal burnt per square foot of grate surface per hour	8·13 lb.
Coal burnt per square foot of heating surface per hour	0·247 lb.
Coal burnt per I.H.P. per hour	1·34 lb.
Coal burnt per pump H.P. per hour	1·59 lb.
Carbon value of coal as used	1·014 lb.
Carbon value of coal equivalent per I.H.P. hour	1·36 lb.
Carbon value of coal equivalent per pump H.P. hour	1·61 lb.
Pounds of water evaporated per pound of fuel	10·7 lb.
Pounds of water evaporated per pound of fuel, from and at 212 Fah.	12·22 lb.
Pounds of water evaporated per pound of fuel per pound of carbon value	12·05 lb.
Pounds of water evaporated per square foot of heating surface per hour	2·64 lb.
Steam per I.H.P. per hour, including jackets	14·2 lb.
Percentage of steam used in jackets	15·7 per cent.
Steam used per pump H.P. per hour	16·8 lb.
Mechanical efficiency of engine, or ratio of pump H.P. to I.H.P.	84·4 per cent.
Water raised 100ft. per pound of coal	12,450 lb.
Water raised in foot-pounds per 112 lb. of coal	139,500,000
Efficiency of boiler, percentage of total heat of combustion taken up by water in boiler	80·4 per cent.

HYDRANT FROST POST.

SOMETHING new in the way of standpipes is especially opportune just now, while the usual sources of water supply are in the grip of the frost fiend, and water direct from the mains during the prevalence of this severe weather is so much resorted to, especially in the poorer districts. The standard



shown is of wrought iron tube, enamelled red, or it may be galvanised, having a gun-metal base for screwing to an ordinary hydrant. At the head are two valves designed for protection against frost. These valves to external appearance are of little or no intrinsic value, being of galvanised iron, therefore not likely to be stolen. This is therefore worthy of the attention of corporations, water companies, and contractors, and to others interested in or affected by water supply. It is made by the Lambeth Brass and Iron Company, of Short-street, Lambeth, S.E.

THE United States Naval authorities intend to repeat the experiments carried out many years ago with submarine boats. The Bureaus of Ordnance, Construction and Repair, and Steam Engineering have made a joint report to Secretary Herbert upon the specifications which should be entered into for the proposed submarine boat. It is provided that the boat shall be 80ft. in length, and its diameter shall be 11ft.; displacement, light, 118½ tons; total displacement when submerged, 138½ tons; reserve buoyancy, $\frac{66}{100}$ths of a ton. The company constructing the boat will have to guarantee 15 knots when the vessel is light, and 14in. awash, and her minimum endurance at this speed must be twelve hours. The submerged speed must not be less than seven knots. The boat is to have two torpedo tubes, and be strong enough to resist the pressure of the water at 75ft. Her builders will be given no speed premium. The department is to have the option of purchasing the vessel at a reduced price if she fails to come up to the specifications.

DESTRUCTION OF CHINESE WARSHIPS AT WEI-HAI-WEI.

THE most important portion of the Chinese fleet — the Northern Division — has practically ceased to exist. The flagship of Admiral Ting, the Ting-Yuen, the Chen-Yuen, the Lai-Yuen—sister ship to the King-Yuen, sunk at Yalu—and the Ching-Yuen, sister ship to the Chih-Yuen, which made such a gallant effort to retrieve Chinese honour in that battle, but was eventually disabled by a collision, as well as gun-fire, and went down—all these, and a quantity of smaller craft, have been either sent to the bottom by successful torpedo hits, or gone down under the effects of concentrated gun-fire.

We engrave this week illustrations of the Ting-Yuen and Chen-Yuen, the two largest armour-plated vessels of the Chinese fleet; engravings of the Lai-Yuen and the Ching-Yuen appeared in THE ENGINEER of October 5th, 1894, where a description was given of the principal events in the action at Yalu. The various dimensions and features of the Ting-Yuen and Chen-Yuen were as follows, they also being sister ships:—Length, 308ft. 5in.; beam, 59ft.; draught, 20ft.; displacement, 7430 tons; indicated horse-power, 6200; speed, 14·50 knots. They were built by the Vulcan Company, at Stettin. The main feature of the design consisted of the armoured citadel, in which were placed two barbette turrets on a diagonal line with reference to the keel. There were twin screws. Before and abaft the citadel the ships were divided into numerous water-tight compartments, which in the vicinity of the water-line were filled with cork. The double bottom, as can be seen from the engraving, extended very far forward and aft. The armament consisted of four 30½ cm.—12in.—Krupp guns, mounted on turntables in the barbettes. In addition to these one 15 cm.—6in.—Krupp was mounted under the poop and another on the forecastle. The citadel and turrets were protected by 14in. and 12in. compound plating respectively, with a backing of 14in. Eight machine guns were mounted on each ship.

As usual, several conflicting accounts are given of the sinking of these battleships. One is as follows:—"The bombardment—on Sunday, 3rd February—had scarcely commenced when the Chinese fleet joined in very gallantly. The great battleship Ting-Yuen used her 30-centimetre guns without effect, but she succeeded in drawing some of the Japanese fire from the island forts to herself. The Lai-Yuen, a smaller ship, stood towards the Japanese and fought well, sustaining considerable damage and many casualties. . . The bombardment was resumed on Monday. The Japanese fleet engaged both forts and ships, and the land batteries bombarded the Chinese squadron. The Chinese battleships were so repeatedly and badly hit that their guns were handled with difficulty and with less spirit. Finally, towards the close of the fight, both of the enemy's battleships, Ting Yuen and Chen-Yuen, were disabled. They gradually settled down, and at length foundered amid loud shouts of triumph from the Japanese on land and sea."

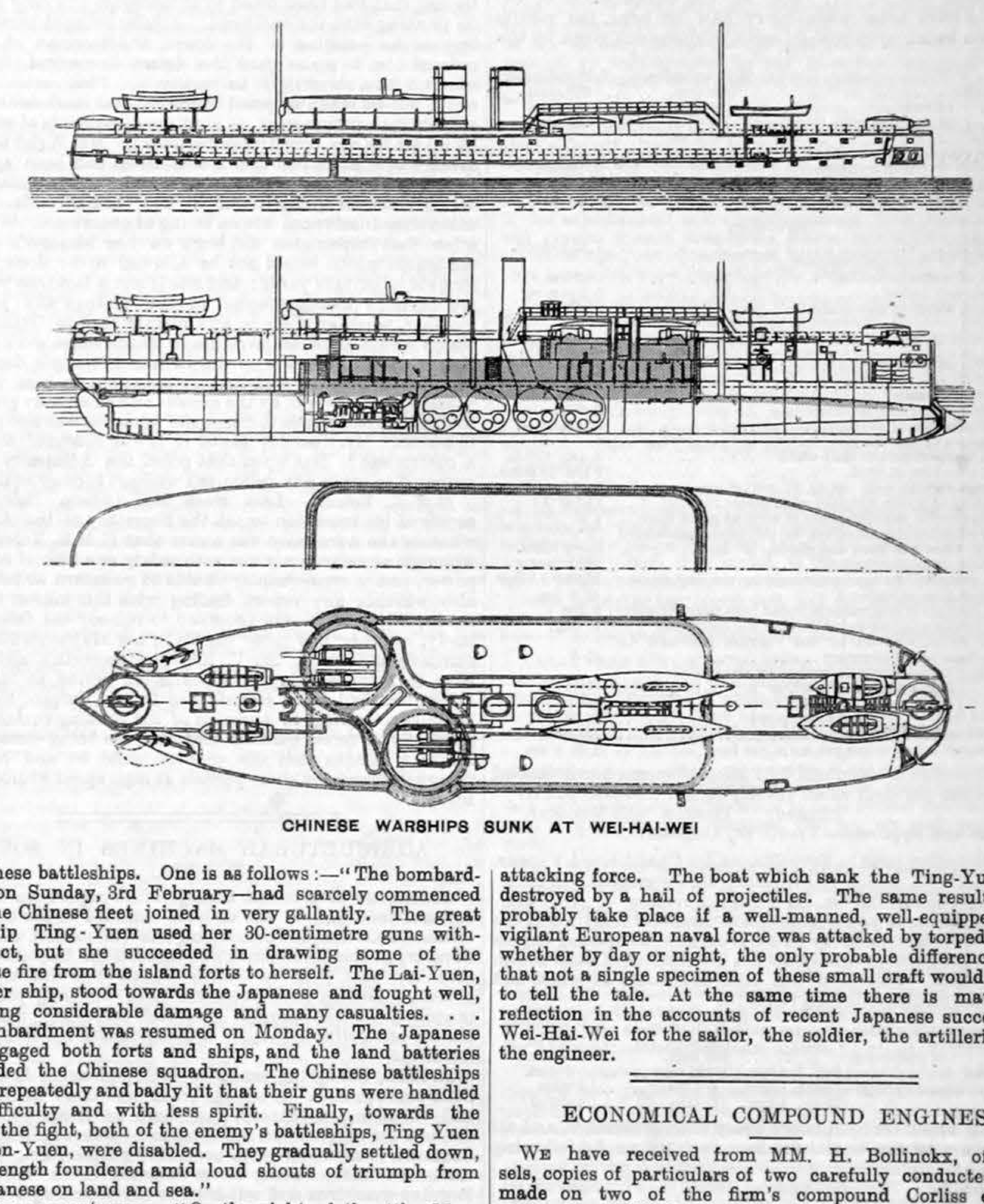
Another account runs:—"On the night of the 4th—Monday—under cover of the darkness, the Japanese torpedo boats stole in, and with a sudden rush launched their projectiles at the great ironclad Ting-Yuen. One took effect and the battleship sank. The cannonade was resumed next morning fiercely on the Japanese side, and more slowly from the Chinese ships and forts. At nightfall the tactics of the previous day were repeated. Several torpedo boats crept into the harbour and succeeded in blowing up the Lai-Yuen, Chen-Yuen, and another ship, name not clear."

The Japanese official account runs thus:—"On the night of the 4th inst.—Monday—the first torpedo flotilla guarded the western entrance to Wei-Hai-Wei Harbour, while the second and third flotillas, after the moon had set, made their way into the harbour through the eastern entrance. Having got inside the harbour, the boats torpedoed and destroyed the large ironclad Ting-Yuen, whilst the bottom of the cruiser Ching-Yuen is supposed to have been damaged. On the night of the 5th the first torpedo flotilla renewed the attack, and torpedoed and sank the cruiser Chih (Ching?) Yuen"—the Chih-Yen was sunk at Yalu—"and probably also the large ironclad Chen-Yuen, the Wai (Lai?) Yuen, and one of the gunboats."

The Japanese account agrees mainly with the Chinese version immediately preceding it. Hence we are inclined to assume that it is correct, and that the graphic description of the Chinese ironclads foundering in the afternoon or evening of the 4th, under fire, amidst the cheers of the Japanese sailors and soldiers, was the result of imagination. The most recent telegrams confirm this opinion. The Chen-Yuen did not actually sink until the 9th inst., though fearfully injured by torpedoes. The *coup de grace* was given her by two shells from the Eastern forts. It will be observed that we have published a detail of the events happening to other vessels besides the Ting-Yuen and Chen-Yuen to shape itself with our description of the fate of these two vessels. It was unavoidable that we should do so.

We gather, then, that the Ting-Yuen and Chen-Yuen, the Lai-Yuen and Ching-Yuen, have been destroyed by the action of torpedoes discharged in the dead and darkness of night, after they were practically disabled by the concentrated fire of innumerable heavy guns, including nearly fifty quick-firing weapons of large calibre. No other result was possible. Not a single heavy quick-firing gun was mounted in the Chinese fleet, and their ships had practically no secondary armament at all. Moreover, the mountings of the main armaments did not permit of the heavy 30½ cm. guns being elevated sufficiently to cover many of the high positions from which they were being attacked on shore, hence the bad practice alluded to in the first telegram quoted. It is satisfactory, however, to note that neither of the battleships or cruisers appears to have gone down under the gun fire—although so terribly concentrated—of their immensely superior enemy. That the ships must sink, if, unprovided with netting, they should be torpedoed, was a foregone conclusion. The only point that remains in obscurity, in regard to these torpedo attacks, is the failure of the Chinese torpedo boats to counteract the efforts of the Japanese. Probably their leading idea was flight and not fight. We cannot, however, admit that the success of the Japanese torpedo boats was in any way conclusive as demonstrating the paramount value of such adjuncts to a naval attacking force. The boat which sank the Ting-Yuen was destroyed by a hail of projectiles. The same result would probably take place if a well-manned, well-equipped, and vigilant European naval force was attacked by torpedo boats, whether by day or night, the only probable difference being that not a single specimen of these small craft would survive to tell the tale. At the same time there is matter for reflection in the accounts of recent Japanese successes at Wei-Hai-Wei for the sailor, the soldier, the artillerist, and the engineer.

"Ting Yuen" & "Chen Yuen."



CHINESE WARSHIPS SUNK AT WEI-HAI-WEI

ECONOMICAL COMPOUND ENGINES.

WE have received from MM. H. Bollinckx, of Brussels, copies of particulars of two carefully conducted trials made on two of the firm's compound Corliss engines, system A. Bollinckx. It has not come to our knowledge that any trial of a compound engine outside the United States has, all things considered, given results more economical. It is true that a triple-expansion engine of 1000-horse power has consumed only 11·893 lb. of steam per horse-power per hour, but here we have compound condensing engines with 90 lb. pressure in the boiler. Messrs. Bollinckx are, we think, justified in saying that the results obtained by them show a remarkable and hitherto unparalleled economy, when it is taken into consideration that from an industrial point of view these engines have beaten all previous records of steam consumption; for if we consider the price of a compound *versus* a triple-expansion engine, the greater amount of friction in the latter—thereby reducing mechanical efficiency—larger foundations and engine-room required, higher cost of maintenance, and wear and tear, then the economy of compound against triple-expansion will come out forcibly. It should also be borne in mind that triple-expansion engines require higher pressure—say 150 lb., for instance—in the boilers, and that consequently boilers for such a pressure are more expensive, and it costs also more to get steam at 150 lb. than at 90 lb.

We give first in a condensed form the results, and then the detailed report of the Association pour la Surveillance des

Chaudières à Vapeur at Brussels, whose director is the well-known M. R. Vinçotte:—

(1) *Compound Condensing Engine, System Corliss A. Bollinckx.*

Diameter of high-pressure cylinder	25·98in.
„ low „ „	41·33in.
Length of stroke	60·05in.
Revolutions per minute	47·87
Duration of trial	9 hrs. 18½ min.
Indicated horse-power—high-pressure cylinder	164·71
„ „ low „ „	140·32
Total	305·03 H.P.
Feed-water used	35,350 lb.
Condensed water from steam pipes	1111·43 lb.
Steam consumption per indicated horse-power per hour	12·052 lb.
Net total steam consumption	34,218·57 lb.

In order to compare this result with those obtained in other engine tests, it is necessary to make a correction for the slightly lesser value of the continental horse-power. For this purpose the above result is to be multiplied by 1·0135, and thus converted the steam consumption is 12·216 lb., instead of 12·052 lb. per horse-power per hour.

(2) *Compound Condensing Engine.*

Diameter of high-pressure cylinder	19¾in.
„ low „ „	31$\frac{1}{16}$in.
Stroke	39⅜in.
Revolutions per minute	64·72
Duration of trial	9 hrs. 13 min.
Indicated horse-power—high-pressure cylinder	102·18
„ „ low „ „	95·67
Total	197 85 H.P.
Feed-water used	24 354 lb.
Condensed water from steam pipes	406 lb.
Net total consumption	23,848 lb.
Steam consumption per horse-power per hour	13·267 lb.
Correction for lesser value of continental horse-power	= 13·446 lb.

"Association pour la Surveillance des Chaudières à Vapeur.

"Brussels, 1st of March, 1894.

"To the Manager of the Saventhem Paper Works

"Co., Saventhem.

"Hereafter you will find the results of the trial of 20th February, 1894, on the new engine supplied by the Société Anonyme des Ateliers de Construction H. Bollinckx.

"The water has been accurately weighed by means of two casks, both holding 377 kilos. at the temperature of 57. Diagrams have been taken every half an hour, the results have been based upon the following dimensions given by the builder:—

	H.P. cylinder.	L.P. cylinder.
Diameter	500 mm.	800 mm.
„ of rod	70 mm.	80 mm.
„ of counter rod	—	50 mm.
Stroke	1·000 m.	—

Scale of springs—

	H.P. cylinder.	L.P. cylinder.
Front	1 mm. = 0·1166 kilos.	1 mm. = 0·0435 kilos.
Back	1 mm. = 0·1198 kilos.	1 mm. = 0·0392 kilos.

Beginning.

Hour	7.53 o'clock.
Number of revolution counter	0
Level of water in boiler	0·095 m.
Pressure at boiler	6·8 atmos.
Level of water in great tank	0·381 m.

Ending.

Hour	5.6 o'clock.
Number of revolution counter	35 795
Level of water in boiler	0·095 m.
Pressure at boiler	7·2 atmos.
Level of water in great tank	0·383 m.
Mean pressure of steam	6·60 atmos.
Stoppages of the engine	0
Mean temperature of feed-water	5 deg. Cent.
Total duration of trial	9 hrs. 13 mins.
Average speed	64·72
Quantity of water weighed with casks	11,123·8
Correction for the difference of level at great tank	4·6
Correction for condensation in the pipes, calculated at 21 kilos per hour and per m.	184·2 kilos.
Water drawn from jacket	781 kilos.
Real quantity of steam consumed by the engine	10,944·2 kilos.
Temperature of exhaust	48 4 deg.
Temperature of the water injected into the condenser	2 deg.
Temperature of the water leaving the condenser	17 deg.
Mean vacuum given by the vacuum indicator in centimetres of mercury	67·5
Average horse-power developed by the engine—	
H.P. cylinder—Front, 43·29; L.P. cylinder	49·31
„ Back, 58·93; „	46·36
Total horse-power	197·87
Total number of hours and horse-power	1823·51
Consumption of steam per horse per hour	6·01 kilos.

"The engine *a* consumed 6·01 kilos. of steam per indicated horse-power per hour when developing 197·85-horse power.

(Signed) "DEJACE, Sub-Manager."

"Seen and approved—VINÇOTTE, Director."

"Association pour la Surveillance des Chaudières à Vapeur.

"No. 987. "Bruxelles, 6th November, 1894.

"Manager of the Ld. Co. La Vesdre, Verviers.

"I beg to hand you herewith the results of the trial of the 2nd of October made by us on your new compound engine built by the Société Anonyme des Ateliers de Construction H. Bollinckx. This trial has been conducted as before and calculated on the following items:—

	H.P. cylinder.	L.P. cylinder.
Diameter	660 mm.	1·050 m.
„ of piston-rod	105 mm.	115 mm.
Stroke	1·525 m.	1·525 m.
Scale of indicator springs—Front, 1 mm.	0·1166	0·0393
Back, 1 mm.	0·1184	0·03799

"Diagrams have been taken every twenty minutes, and all the ciphers of the trial have been written on the following board:—

Beginning of Trial.

Hour	6·41½ o'clock.
Revolution counter	0
Water level in boiler	0·100
Water level in great tank	0·054
Pressure at boiler	6·15 atmos.

End of Trial.

Hour		5 o'clock.
Revolution counter		26,738
Water level in boiler		0·103
Water level in great tank		0·057
Pressure at boiler		6·2 atmos.
Weight of casks—180·5 kilos. and 187·95 kilos.		
Mean pressure		6·2 atmos.
Stopping of the engine		1 hour.
Real time of duration of trial		9 hrs. 18½ min.
Mean speed		47·87
Quantity of water measured with cask, $187·99 \times 44 \times 180·5 \times 43 \times \frac{1·00226}{1·00353}$	=	16,021·1
Correction for difference of level at boiler	−	8·83
„ „ „ „ great tank	+	2·35
Condensation in the piping 445·20 kilos. / Correction for loss per evaporation 58·38 kilos	−	503·58
Condensed water from the H.P. cylinder jacket 912·66 / Correction for loss per evaporation 119·67		1032·33
Real quantity of steam consumed by the engine		15.511·04 kilos.
Mean temperature of steam after L.P. cylinder		45 deg.
Temperature of the water injected in the condenser		11 deg.
„ „ „ leaving the condenser		21 deg.
Mean vacuum		69·99 deg.

Horse-power developed—	
H.P. cylinder—Front, 74·42; L.P. cylinder—Front, 67·52 / „ Back, 90·09; „ Back, 73·52	305·03
Total number of horse-power and hours	2838·93
Steam consumption per horse per hour	5·46 kilos.
Mean effective pressure in high-pressure cylinder	1·50 atmos.
„ „ „ low „ „	0·50 atmos.

"The engine has consumed 5·46 kilos. of steam only per indicated horse-power per hour.

"Admission at high-pressure cylinder amounted to about 10 per cent. The vacuum taken with the indicator has been 69·9 of mercury. The diagrams are beautiful, and do not show any appreciable defect.

(Signed) "DEJACE, Sub-Manager."

(Signed) "R. VINÇOTTE, Director."

PARLIAMENTARY NOTES.

Shipwrights as fitters.—On Monday Mr. Wrightson asked the Secretary to the Admiralty whether it was the practice of the authorities in Devonport and Pembroke Dockyards to employ shipwrights who were workers in wood to do the work of fitters who were workers in iron; and whether, in the case of the iron water-tight doors in the Renown, now in Pembroke Dockyard, they have been so defectively fixed by shipwrights that properly-trained fitters had to be finally employed to rectify these defects before the proper tests could be applied. Mr. E. Robertson replied on behalf of the Admiralty. He said that the practice at all the dockyards is to employ men of the trade called shipwrights on work in connection with the construction and repairs of the hulls and fitting of ships, usually done in private yards by iron shipbuilders, shipwrights, and fitters. The dockyard shipwright is, and has been for over thirty years, a worker in metal as well as in wood. The only ground for the statement in the second part of the question is as follows:—The water-tight doors of the Renown were supplied by contract and separated from their frames by fitters at Pembroke Dockyard. The shipwrights fitted and fastened the frames of the doors to the bulkheads of the ship. The doors were then attached to the frames by the fitters and subjected to the usual water test, when it was found that out of nine frames that had been fitted by shipwrights one only leaked at its jointing with the bulkhead. A fitter being at hand attending to the hanging of the doors, the foreman of the ship ordered him to make good the defect discovered, instead of sending for a shipwright to rectify it. This small incident could not be taken as proof of the general inefficiency of the shipwright's fitting work, as similar adjustments of work done by all trades are sometimes necessary. Mr. Wrightson then asked was it not a fact that a committee had been appointed to decide what was carpenter's work and what was fitter's work? Mr. Robertson thought that it was not so. Mr. William Allan then intervened with a string of questions. Was it not a fact that shipwrights did work on her Majesty's ships in dockyards which would not be allowed to be done by shipwrights in private yards; and was it not a fact that you could see daylight through some of the fittings and joinings? Further, whether there is any private yard in Great Britain which would allow shipwrights to do the same work on ships that shipwrights have to do in her Majesty's dockyards? Mr. Robertson answered that it appeared to him that that question was covered by the answer he had already given. As to daylight being seen through the joins, he was not prepared to assent. Mr. Kearsley asked if it was intended to appoint a committee? But upon that point the Admiralty was not prepared to make any statement without further notice.

H.M.S. Vulcan.—Last week Mr. Gibson Bowles gave notice of his intention to ask the Secretary to the Admiralty whether the Admiralty was aware that H.M.S. Vulcan could when going astern only use with safety one-fifth of her horse-power, and is consequently unable to go astern at full speed; also whether any report dealing with this matter had been made; whether it was proposed to remedy the defect; and, lastly, whether any other vessels in her Majesty's Navy were similarly defective. Sir U. Kay-Shuttleworth's answer was that in going astern for a prolonged period at high speed difficulties had been experienced in the Vulcan, Hood, and Trafalgar, "owing to abrasion of the rubbing surfaces; consequently a more suitable material was being substituted." He said further that the engines could be and had been "worked astern for short periods at high speed without risk or trouble."

AGRICULTURAL MACHINES IN SOUTH RUSSIA.

ACCORDING to a recent Foreign-office report on the agricultural condition of the district included in the Consulate-General of Odessa, and comprising Kieff, Nicolaieff, Odessa, and Sevastopol, the development of agricultural implements and machines last year in South Russia was enormous, and although British manufacturers have for long possessed a monopoly in the supply of steam-threshing machinery, serious competition therein is threatened from Hungary and America.

In Kieff, the spring trade in drills, ploughs, &c., was of little consequence. A capital trade was done in harvesting and threshing machinery, and there never has been such a demand for reapers and self-binders as was experienced over Southern Russia last year, over 2000 reapers, &c., mostly of American make, having been disposed of in Kieff alone. Reaping machines and self-binders are becoming a necessity to every farmer, in view of the excessive demands made by the peasants during harvest operations, who prefer to harvest their own crops first, while the proprietor must need wait. When the peasants have secured their grain, and consequently their own living for the winter, they have not much inclination to work, and proprietors are more or less in their hands, unless they provide themselves with machinery. A very large trade was done in horse-threshing machinery, of German and local make, and the demand is still brisk. In view of the ruinous prices for agricultural produce, it is natural to suppose that the sale of agricultural machinery would be considerably diminished, but in the hope that prices are bound to advance, both peasants and proprietors prefer to thresh their grain, and to do this they must increase the available plant. I learn threshing machinery was in great demand, and there has seldom been so many "sets" sold in any one season. The larger portion of this trade is in the hands of British manufacturers, but serious competition is threatened from Hungary and America. The Hungarian State Railway Works of Buda-Pesth opened branches in Kharkoff and Kieff early last year, and disposed of forty-five "sets," a very fair beginning, but they guaranteed their machines to do 20 per cent. more work than any British-made thresher. As the Hungarian thresher is a copied combination of those of the best known British makers, it is difficult to understand how such a result has to be obtained, but doubtless the buyers of the machines had this in view when making their purchases. Naturally, considering that a thresher which would do a fifth more work than those hitherto used was worthy of consideration. One British firm, upon an opportunity being given, tested its threshing, set against one of the same power made by the Hungarian Railway Works, and after a three days' trial came out victorious, both as to quantity and quality of work done. It must be borne in mind that although the Customs duty is equal all round, a country like Hungary, with a high protective tariff, and in which machinery enjoys a low if not free freight to the Russian frontier, can always export her goods and dispose of them cheaper in Russia than they are sold at home. American threshers are being introduced by the Minister of Agriculture. The class of threshing machinery used in America was favourably noticed by the Commissioner of Agriculture in his visit to the Chicago Exhibition of 1893, and several sets have been imported by the Government. An official trial of one of these sets was to take place in November last on the estate of Count Tolstoi, in the Government of Orloff, and the result of this competition will be well worth the attention of British manufacturers. The American threshing machine is so much lighter in weight that the difference in duty is very considerable, a 10-horse power portable engine of American make paying from £40 to £50 less duty than a similar British-made engine. In view of these differences, it is to be hoped that the various persons interested in the trade may take steps to retain the Russian market for this class of machinery, and not allow it to slip through their fingers as they did the plough trade for want of a little hearty enterprise, as a departure from their standard notions as to how the machine ought to be made or the manner of conducting the trade.

In Nicolaieff the business done in agricultural implements and machinery was unprecedented. The prospects of a good crop created almost a rush for reapers, and as early as May many of the local makers were cleared out of their stocks. The consignments of engines and threshing machines were also very heavy.

In Odessa agricultural implements of all sorts were in great demand, and an enormous sale took place, but as these are, as a rule, sold on long credit, it remains to be seen whether the purchasers will, in the present depressed state of agriculture, be able to pay up their instalments.

TRADE ANNOUNCEMENTS.—Mr. George Offor announces that he has opened an office at 78, Mansion House Chambers, Queen Victoria-street, E.C., where he will continue the business of contractor for the supply of electricity.—Messrs. Peirson and Co., of 124, Fenchurch-street, send particulars of their Simplex ventilating system for ventilating electric manholes by means of pipes and outlets of special form, from the manhole to the pavement curb or to a wall, as may be most convenient.—We are informed that Normandy's Patent Marine Aërated Fresh Water Company, of Philip-street, Victoria Dock-road, E., the well-known Admiralty distilling machinery contractors, has acquired from Mr. Leslie S. Robinson, A.M.I.C.E., of 28, Victoria-street, S.W., the sole rights in this country of supplying the Normand patent feed-water heater.—Messrs. Fleming and Ferguson, shipbuilders and engineers, Paisley, have contracted with the Crown Agents for the Colonies for the supply of a tug steamer for the harbour works at Trinidad, and have also received orders from the Egyptian Government for a twin-screw steamer for Alexandria. They have also secured a large order from the Brighton Corporation, consisting of engines, boilers, and pumps, in connection with the now Corporation waterworks.

CHERRY'S CALCULATOR.—We have received a copy of Mr. Henry Cherry's "Calculator," which consists of a logarithmic scale divided into twenty lengths of lines 5in. long, about ⅛in. apart, and graduated so as to perform, with the aid of a transparent slip, the functions of a logarithmic slide rule. The scale is printed on a card, and mounted in a pocket case. The slips referred to may be made of tracing paper by the user; but with the calculator are some slips varnished on one side, so that marks or ticks may be made upon them with ink, for showing the proper position for superposition above the logarithmic scale, the ticks taking the place of the cursor in a Gravet rule. The length of the scale—100in., counting the twenty 5in. lines—gives considerable size to the spaces between integers, and makes it possible to calculate with accuracy to less than $\frac{1}{10}$th of 1 per cent., even where the figures are taken from the smallest divisions in the high numbers of the scale. The slips referred to are not very clearly printed or well numbered, being looked upon as things which any one can make for himself; but this is a mistake—Mr. Cherry should have them clearly printed, and save others the trouble. The pencil-marked slips will probably be preferred to the varnished slips for use with ink, although the ink is easily removed. Like every other designer of a slide rule, Mr. Cherry has failed to make his instructions as clear as they might and should be. He describes the processes for multiplication, division, combinations of these, and their continuations, but he does not give examples until he comes to the extraction of complex roots. An example for each of the processes would greatly facilitate the learning of the use of the calculator. Unless its use is made easy, the instruction given in the name of the calculator—"Forget-me-not"—is not likely to be obeyed. Once learned, there is no doubt that the calculator might afford considerable help as an instrument for use in the office. It is made by Mr. Henry Cherry, of 21, Festing-road, Putney.

STEAM TRACTION ON COMMON ROADS.—On Monday last a paper was read by Mr. Stephen H. Terry, M. Inst. C.E., of Kingston-on-Thames, on "Steam Locomotion on Common Roads." After a short account of the early history of steam locomotion on common roads, the author referred to the history of road locomotives for heavy haulage, beginning with Boydell's locomotive, and describing also the inventions of Barrell, Aveling, and others. It was mentioned also that there are now some 8000 engines engaged in road locomotion throughout the kingdom, which, at an average indicated power of 10-horse, are doing work which would require 80,000 horses to effect, at a saving to the country of £10,000 a day, or over three millions a year. Of course this large profit does not fall into the hands of traction engine owners, it goes chiefly to cheapen the cost of distribution. The horses necessary to do the work done by these engines if placed in line would reach nearly from London to Liverpool. What is now required is a comprehensive Act permitting the owners of traction engines to take out one licence for each engine, which should give permission to travel in any part of the kingdom, and it should be put out of the power of adjacent authorities to block the passage of such traffic. The wheel question requires revision, and in view of the progress of mechanical science in every other direction, the use of passenger steam carriages should be encouraged by the formation of a new rule in regard to speed for locomotives under one ton in weight, such engines, if properly mounted on springs provided with suitable wheels, should be permitted to run at eight miles an hour in the country, and five miles in a town, the slower speeds at present existing applying only to engines for heavy haulage. At the present moment France is ahead of us in steam-propelled carriages and it is time that the Legislature, which has done so much to cripple what might have become an important industry, namely passenger traffic by steam on common roads, should remove the disabilities under which it labours

RAILWAY MATTERS.

THE West Highland Railway has been cleared after arduous labour.

A NEW survey has been ordered for a railway from Mogaung to Myitkina on the Irrawaddy.

THE Beira Railway is completed as far as Chimoio, making in all a distance of 118 miles. Already the traffic on it is considerable.

MR. T. B. COLLIER has been appointed Rolling Stock Controller of the Manchester, Sheffield, and Lincolnshire Railway in place of Mr. C. G. Cowlishaw, deceased. Mr. Collier was for twelve years chief assistant to Mr. Cowlishaw.

THE Belt Line Railway, in Baltimore, is fast approaching completion. It is expected that the entire line will be equipped and ready for operation by April 1, 1895, excepting the station buildings, upon which work has not yet commenced.

THE cost of maintenance of way and works of the North-Eastern Railway during the past half-year reached £396,226 16s. 10d., of which the wages for maintenance and renewal of permanent way were £113,691 5s. 6d., the materials costing £79,068 9s. 3d. These costs relate to 1622 miles of railway.

MR. MONTAGUE DIMOOK TYRWHITT, of Wallington, near London—cousin of Sir Raymond Tyrwhitt—who died on Monday morning, was for many years the deputy manager of the South-Eastern Railway Company. Quite recently Mr. Tyrwhitt had the Knighthood of the Order of Leopold conferred on him by the King of the Belgians.

SOME railway companies who have adopted systems of railway-carriage heating by various methods are seriously considering the question of whether the expense thus incurred is warranted, considering the manner in which the trains are burdened with heavy and costly fittings to be run all the year round, and the very limited benefit thereby.

IT is proposed to construct a light railway from Pwllheli to Abersoch, Sarn, and Nevin, Carnarvonshire. The Cambrian Railways run to Pwllheli, and the London and North-Western Railway to Afonwen—four miles from Pwllheli—where the two lines join, but in the large healthy agricultural district between Pwllheli and Aberdaron, a distance of about twenty miles, there is no railway.

THE North-Eastern Railway Company seek power, in their Bill of next session, to construct just over 4½ miles of new railways and widenings in the county of Northumberland, and over 6¼ miles of new lines and widenings in the West and North Ridings of Yorkshire. In Durham the company propose no new railways, but powers are sought to improve their Newcastle and Carlisle Railway near Blaydon.

ACCORDING to an official statement issued by the French Ministry of Public Works, the mileage of the French railways at the commencement of the year 1895 was as follows:—The total length of lines open for traffic was 22,792 miles, being an increase of 287 miles upon the previous year, while the length of local lines open for traffic was 2331, or 99 miles more than a twelvemonth ago. The total length of tramways open for traffic was 1175 miles, while concessions had been granted for 685 miles more.

THE North British Railway Company's offer of £14,000 has been accepted by the Corporation of Edinburgh for the wholesale Fishmarket, part of the Regent-road Park required for line extension there, vacant ground at Cranston-street, portion of the Calton Rock, and wayleave for the tunnel at Regent-road, the corporation discharging their claim for temporary occupation in the Princes-street Gardens during the recent operations and their claim for the expense of screening the railway in Princes-street Gardens.

THE report of the Midland Railway Company for the half-year ending December 31st, 1894, states that there are 1326¾ miles of railway constructed, exclusive of 634½ miles of which the company is part owner. The train mileage, excluding that run for other companies, for passenger, goods, and mineral trains, is 19,829,522, which is in excess of that for the corresponding half of the previous year by 1,632,126 miles. The total locomotive running expenses are £564,446 12s. 1d., or less than that of the corresponding previous half-year by £23,843.

WE learn from the report of the London and North-Western Railway for the half-year ending December 31st, 1894, that the train mileage of passenger trains is now 11,292,115, and that of their goods and mineral trains is 10,012,802, the former being less than that of the corresponding half of the year 1893 by 120,035, and the latter, taken similarly, being in excess by 309,837. The mileage of lines at present constructed, exclusive of 197 miles of lines partly owned, leased, or rented, is 1668¾. The total locomotive running expenses are given as £530,876 14s.—less than that of the corresponding previous half-year by £39,757.

THE report of the North-Eastern Railway Company for the half-year ending December, 1894, shows that the miles operated by the company's locomotives were altogether 1622, with 148¾ miles of foreign lines worked over. In working this mileage the locomotives of the company made 6,610,374 passenger train miles and 7,956,879 goods and mineral train miles, or a total of 14,567,253 miles at a cost for locomotive power of £634,286 7s. 10d. Of this total cost that for coal and coke was £158,916 16s. 7d. Repairs and renewals cost £197,417, and the wages connected with the working of the locomotives reached £221,929 12s. 10d.

IT is proposed to lay an electric tramway from Colwyn Bay to Conway through Deganway to Llandudno. The ground has been inspected by a party of engineers, and the company of inspection have expressed their willingness to lay down the whole line, including the construction of a swing bridge over the river Conway if the local authorities grant their consent. If the Llandudno District Council will give permission for the tramway to go along Mostyn-street and Mostyn-street extension to Craigside—the eastern end of the town—the work of laying down the Deganway portion will be at once commenced, the survey of the entire line gone on with, and a provisional order applied for at the next session of Parliament.

THE Board of Trade report on the accident at Chelford, on the London and North-Western Railway, on December 24th, by which fourteen passengers were killed, has just been issued. The report states that after the first collision between the shunting wagons no human effort could have averted the collision which ensued, and Major Marindin does not think that the smallest blame can be attached to any of the company's servants working the express, all of whom, as well as the station staff, seem to have behaved admirably after the collision. Nevertheless, he does not consider that the first collision was inevitable. He exonerates the stationmaster from all blame, but observes that the empty wagon was driven back about 131ft. by the force of the wind, and the collision would therefore not have occurred if the stationmaster had realised that the wind was sufficient to move the wagon, for then he would have put on the wagon brake. He advises the Associated Railway Companies to lay down in their book of rules that during high winds all wagons are to be kept attached to the engine when being set back on to their trains, or that, where this would lead to unreasonable delay, all wagons shunted back loose shall have the brake pinned down as soon as they come to a stand, no matter what the gradient may be. Moreover, all wagons should be fitted with a brake-handle on both sides, instead of upon one side only.

NOTES AND MEMORANDA.

ACCORDING to a process devised by M. Henri Moissan, a boride of iron of the composition FeB is obtained by heating together iron and boron, best in the electric furnace. It forms brilliant grey crystals, which remain unaltered in air or dry oxygen. Its density is 7·15 at 18 deg. C.

A THERMOMETER somewhat similar to an ordinary alcohol thermometer is used in France for measuring very low temperatures, the liquid employed being pure toluen, the dilatation coefficient of which is very high. This liquid is also exceedingly mobile, another feature which greatly adds to the sensitiveness of the instrument.

AN alloy consisting of aluminium with 8 per cent. of copper and 12 per cent. of zinc is being used in America for bicycles. The castings are said to be very rigid. Another alloy, consisting of aluminium with 3 per cent. of German silver, also gives good results. As cast its specific gravity is 2·73, and its tensile strength 10 tons per square inch. By rolling the former is brought up to 2·83, and the latter to 18½ tons per square inch. This alloy is whiter than pure aluminium.

FOR cementing purposes opticians get the oldest Canada balsam they can obtain, and drive off nearly all the essential oil left in it, by long-continued moderate heat; the residual resin is then made slightly less brittle by dropping into it, when melted, an exceedingly small portion of castor oil; it is easy to add too much of the latter. The *English Mechanic* says that the object is to get a transparent cement which will neither crack with age nor permit the formation of arborescent markings between the glasses from evaporation of essential oil.

AN instance of the great dissolving powers of sulphuric acid is furnished by an accident which recently occurred in the chemical factories Mulhouse, Alsace. An operative was blown by an explosion of nitro-benzol up into the air, and fell down into a large trough which was filled about 3ft. deep with sulphuric acid, the temperature of which was found to be 91 deg. C. ten hours after the accident. The death of the man in this trough was only proved by the discovery of his caoutchouc respirator, muzzle, two porcelain buttons, and other difficultly soluble articles. Everything else had chemically combined with the acid.

PROFESSOR CALVERT has recently arrived by practical tests at the conclusion that the carbonates of potash and soda possess the same property of protecting iron and steel from rust as do those alkalies in a caustic state. Thus it is found that if an iron blade is immersed in a solution of either of the above carbonates, it exercises so protective an action that that portion of the iron which is exposed to the influence of the damp atmospheric air does not oxidise, even after so extended a period as two years. Similar results have also been obtained with sea water on also adding to the same the carbonates in suitable proportions.

THE Meteorological Society recently discussed a paper by Mr. C. Harding on the gale of December 21st-22nd, 1894, over the British Isles. This storm was one of exceptional severity, especially over the northern portions of England and Ireland and in the South of Scotland. It developed energy very quickly, and travelled with great rapidity. The self-recording anemometers show that the greatest violence of the wind occurred at Fleetwood, where the velocity was 107 miles in the hour between 8.30 and 9.30 a.m. on the 22nd; and for four consecutive hours the velocity exceeded 100 miles. This is the greatest force of wind ever recorded in the British Isles, and is 10 miles an hour in excess of the highest wind velocity in the great storm of November 16th-20th, 1893. At Holyhead the wind in squalls attained the hourly velocity of 150 miles between 10 a.m. and noon on the 22nd. The strongest force was mostly from the north-westward.

THE wheat-bearing acres of the world are less by 3 per cent. than they were in 1884. The reduction in the United States alone exceeds the entire wheat area of their new South American rivals. During the last four years the product from the world's wheatfields has been nearly 600,000,000 bushels more than it would have been had the yields from 1891 to 1894 averaged no more per acre than during the fourteen years ending with 1894. The world's requirements for wheat increase are put at the rate of 25,000,000 bushels a year, or an accumulated aggregate since 1884 of 250,000,000 bushels. But in the United States alone there has been a recent increase above average yields of 370,000,000 bushels, so that the United States extraordinary contributions to the world's supply have left a considerable surplus. But, says the *Commercial Bulletin*, New York, this surplus is rapidly disappearing, and we are coming face to face with this state of facts, that the bread-eating populations have increased 13 per cent in ten years, while the wheat acreage has shrunk 3 per cent.

THE Société Technique de l'Industrie du Gas en France offers several prizes for the 1894-5 competition, of which the following are open to all. A prize of 10,000f., or £400, for the inventor of an incandescent burner showing marked superiority, to be handed in before April 1st of the present year, though the committee have power to extend the time for a year. The sum of 8000f.—£320—will be devoted to prizes to be awarded to the authors of the best papers on some subject connected with the gas industry, including the mechanical handling of coals, cokes, and various substances in various gas works, and a study of water gas. A further sum of 2000f.—£80—will be distributed in rewards to those who have made considerable improvements in apparatus for the production or utilisation of coal gas. The papers must be written in French, and not bear the name of the author; but must contain at the beginning a motto reproduced on a sealed envelope, in which the author will sign a declaration that his work is unpublished, and that he will not make any other publication on the same subject within a year. The manuscripts, with sealed envelope, must be sent to the above-named society, 65, Rue de Provence, Paris, at least forty days before the day fixed for the congress.

AT Bangalore, in Southern India, the quarrying of granite slabs by means of wood fire has been brought to such perfection that an account of the method is given as follows in *Nature*:—The rock forms solid masses uninterrupted by cracks for several hundreds of feet, and when quarried over an area is treated as follows: A narrow line of wood fire, perhaps 7ft. long, is gradually elongated, and at the same time moved forward over the tolerably even surface of solid rock. The line of fire is produced by dry logs of light wood, which have been left burning in their position until strokes with a hammer indicate that the rock in front of the fire has become detached from the main mass underneath. The burning wood is then pushed forward a few inches, and left until the hammer again indicates that the slit has extended. Thus the fire is moved on, and at the same time the length of the line of fire is increased and made to be convex on the side of the fresh rock, the maximum length of the arc amounting to about 25ft. It is only on this advancing line of fire that any heating takes place, the portion which has been traversed being left to itself. This latter portion is covered with the ashes left by the wood, and with thin splinters which have been burst off. These splinters are only of about ⅛in. thickness, and a few inches across. They are quite independent of the general splitting of the rock, which is all the time going on at a depth of about 5in. from the surface. The burning lasts eight hours, and the line of fire advances at the average rate of nearly 6ft. an hour. The area actually passed over by the line of fire is 460 square feet, but as the crack extends about 3ft. on either side beyond the fire, the area of the entire slab which is set free measures about 740 square feet. All this is done with, maybe, about 15 cwt. of wood. Taking the average thickness of the stone at 5in. and its specific gravity as 2·62, the result is 30 lb. of stone quarried with 1 lb. of wood.

MISCELLANEA.

THE Sunderland Rural District Council have engaged Mr. D. Balfour, M. Inst. C.E., of Newcastle-on-Tyne, to report on a main sewerage scheme for Grangetown, Sunderland.

THE marriage is announced of Mr. Bennett H. Brough, the secretary of the Iron and Steel Institute, and Barbara, the niece of Major-General Lloyd, on Thursday, the 21st inst., at Christ Church, Lancaster Gate.

THE Baldwin Locomotive Works having removed the overhead shafting from that portion of its machine-shop devoted to wheel work and installed an electric motor for each machine, *Railway Engineering and Mechanics* says that the saving effected in fuel is said to be nearly 40 per cent.

THE frequent conflagrations, both in Japanese and Chinese vessels, at the battle of the Yalu have caused the French Government to increase the powers of fire extinction in their war vessels, and tubes for forcing steam jets to different parts of the hull are being fitted.

THE plans and specifications of the Cairo city sewerage works are now complete. The French have shown great anxiety to secure the appointment of a Frenchman as superintendent engineer. The salary is £E1500 per annum, but no definite action has yet been taken by the Ministry of Public Works.

A PAPER was recently read before the Aberdeen Mechanical Society on "Granite Working Machinery and Appliances" by Mr. T. M. Henderson, jun. The author expressed surprise at the little attention given by the people of Aberdeenshire to their great native granite industry. Various operations in quarrying were described, also the manufacture of adamant, and the various machines employed in both, were minutely dealt with.

BY an order of the Spanish Government just issued, says the Liverpool *Journal of Commerce*, all steamers sailing under the Spanish flag, or subsidised by the Spanish Government, will, in future, carry none but Spanish engineers. The prevailing practice at present is to carry at least two British engineers on each Spanish steamer, and formerly all the engineers were British. This wind, if it will blow no good to British engineers will probably blow some to the repair establishments of the ports concerned.

THE report of the Kensington and Knightsbridge Electric Lighting Company shows that after providing for various expenses and reduction of debenture accounts, paying the dividends on the 6 per cent. first preference shares and on the 5 per cent. second preference shares, an interim dividend of 5 per cent. on the ordinary shares for the first half of the year, it has been decided by the directors to pay from the remaining profits a further dividend of 5 per cent. on the ordinary shares for the past half year.

THE armoured cruiser Dupuy-de-Lôme, 6300 tons, has, after repeated alterations, says the *Times*, again failed to answer satisfactorily the demands made on her. She is a long narrow vessel with three screws, and the three sets of engines constantly hamper one another. This vessel was launched in 1890, and is still in the experimental and alteration stage. The Americans have had greater success with three screws in the Minneapolis and Columbia class, but those vessels, in addition to greater lengths, have nearly 7ft. more beam than the Dupuy-de-Lôme.

A BOARD of Trade report has been published under the Boiler Explosions Act, on the displacement of a steam receiver, or large pipe which received the steam from a battery of seven Lancashire boilers. At one end of the receiver was a blank flange, and at the other an expansion joint on a pipe without guard bolts. This pipe could not move, so the unbalanced pressure pushed the whole receiver away from it, and pushed over a stone abutment, which had been built to prevent the movement which occurred. They do some odd things in some colliery engineering departments.

ALL the daily papers have it that the engineers of the s.s. La Gascogne soldered one of the cylinders. We suppose this is meant for "isolated." What appears to have occurred is as follows:—The piston-rod of the third intermediate cylinder broke transversely, owing, it is stated, to the presence of water in the cylinder, necessitating an immediate stoppage of the engines. The cylinder head was not blown out, but the steam connections required considerable alteration. To carry out this work the whole force of no less than eighty men was put on continuous duty.

CELLUVERT fibre is now being formed into pump cups and hats by Messrs. David Moseley and Sons, of Manchester, from whom we have received a specimen cup for pumps working under very high pressures. These cups have now been in use for a considerable time, and experience proves that their life is at least equal to that of leather, and some users prefer it to that material at the same price. These cups and rings are also being used in air compressors, and we understand that after many months of use they have proved on examination to be in perfect condition. The cups, judging from the specimen sent us, are well and cleanly made.

AN ingenious apparatus for checking the time of entry of workmen at factories in a way that admits of no dispute has been made by Messrs. Pascall and Stocker, of Waterloo-road, S.E. A clock is fitted with a tube holding a column of numbered tickets or blanks, which are released one by one at every five minutes or other suitable interval, and are received in a shoot or tube. The workers drop their tickets into the same tube as they enter the factory. The mixed tickets are taken out in a column or pile, and, being sorted, the tickets dropped by the clock indicate the time at which the workmen's tickets were placed in the apparatus, as the latter are between the clock tickets.

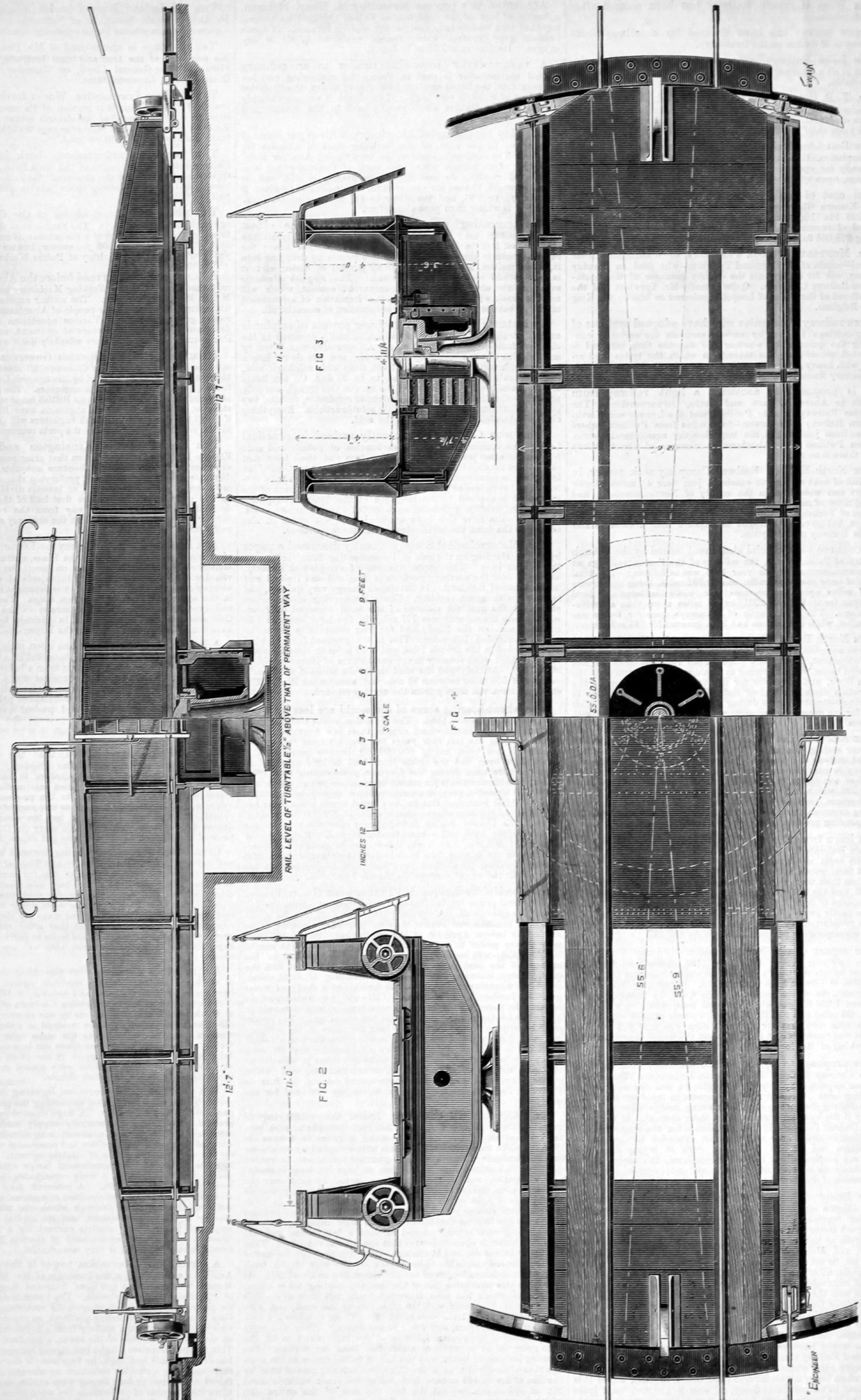
THE progress of the electrical lighting industries is well shown by the tabular statistics concerning the past year's progress, published by the *Electrician*. A large sheet shows at a glance the gradual introduction of electricity supply works in all our busy centres of industry, and a sketch map illustrates the systems adopted by the local authorities and companies who are responsible for the supply to the public of electric current. Curves show the increase in use of the incandescent lamps during the past four years; and this increase is truly remarkable, reaching the large total of 1,600,000 in 1894. A coloured map shows the areas allotted to the various metropolitan companies and local authorities, the thoroughfares through which the mains are laid, the position of the supply stations, and the capital outlay at present employed in providing electric current for a rapidly increasing demand. The rapid development of electric lighting enterprise from January 1st, 1893, is very remarkable.

A REVOLVING observation tower is the latest "exalted American notion." It is the invention of Mr. Morris F. Smith, of Messrs. William Cramp and Sons' Ship and Engine Building Co., of Philadelphia, Pennsylvania. The tower is designed principally for pleasure resorts, to afford from its revolving, and at the same time ascending or descending platform, an uninterrupted bird's-eye view of the surrounding scenery from a comfortable seat provided on the platform outside of the tower, a hundred or more feet high. This design comprises a light but strong hexagonal steel tower one hundred or more feet high, by fourteen or more feet in diameter, surrounded by a circular structure or elevator. This elevator is raised or lowered by four strong wire cables, each one of which is more than capable of performing the work alone. On this elevator is a circular platform, fitted with rollers and intended to revolve upon the elevator. This latter platform is provided with revolving chairs, accommodating 150 or more persons. The first of these towers is to be erected at Atlantic City, U.S.A.

FIFTY-FIVE FEET SURFACE TURNTABLE, GREAT WESTERN RAILWAY

MR. W. DEAN, M. INST. C.E., SWINDON, ENGINEER

(For description see page 187)



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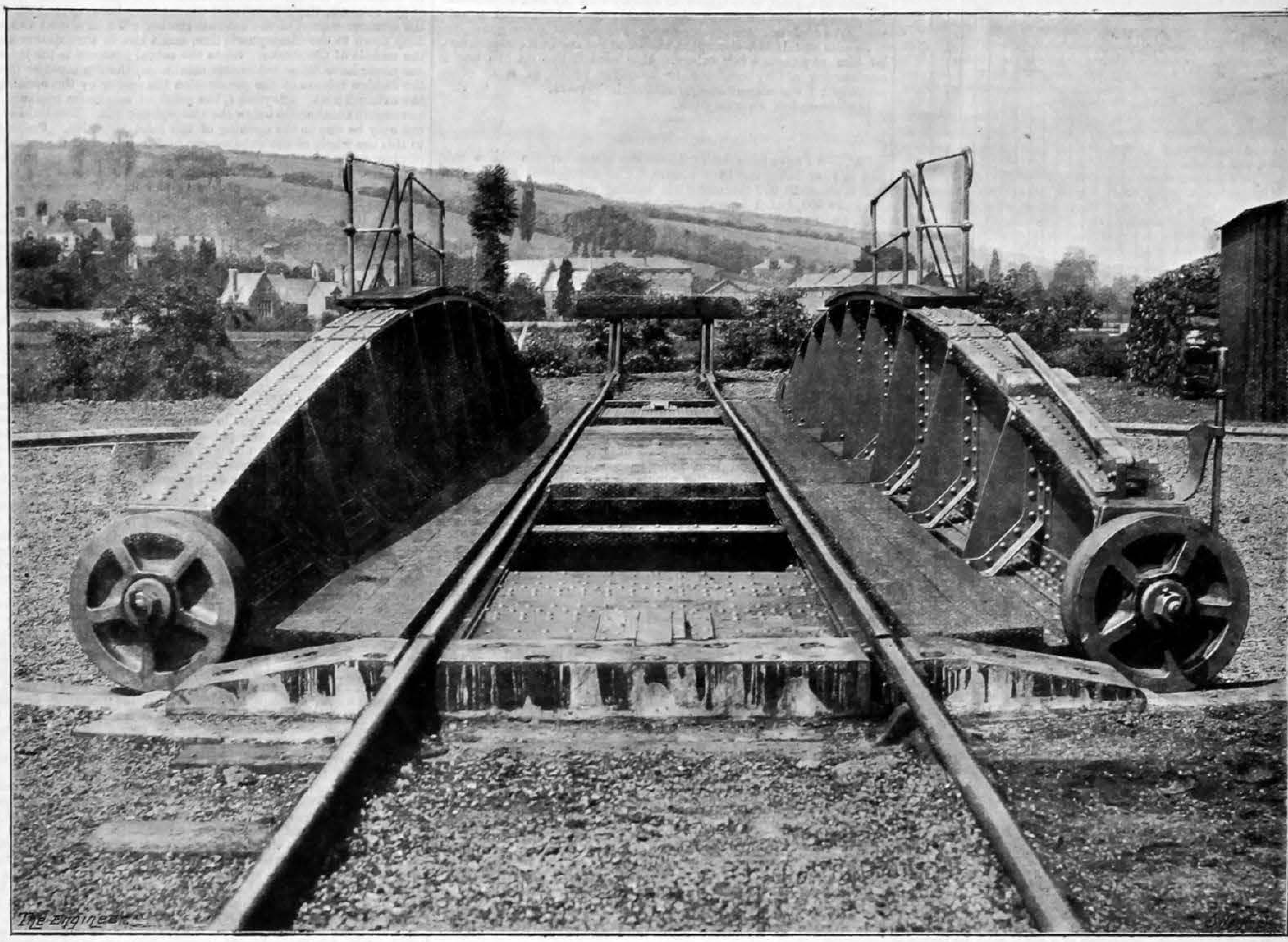


FIFTY-FIVE FEET SURFACE TURNTABLES, GREAT WESTERN RAILWAY.

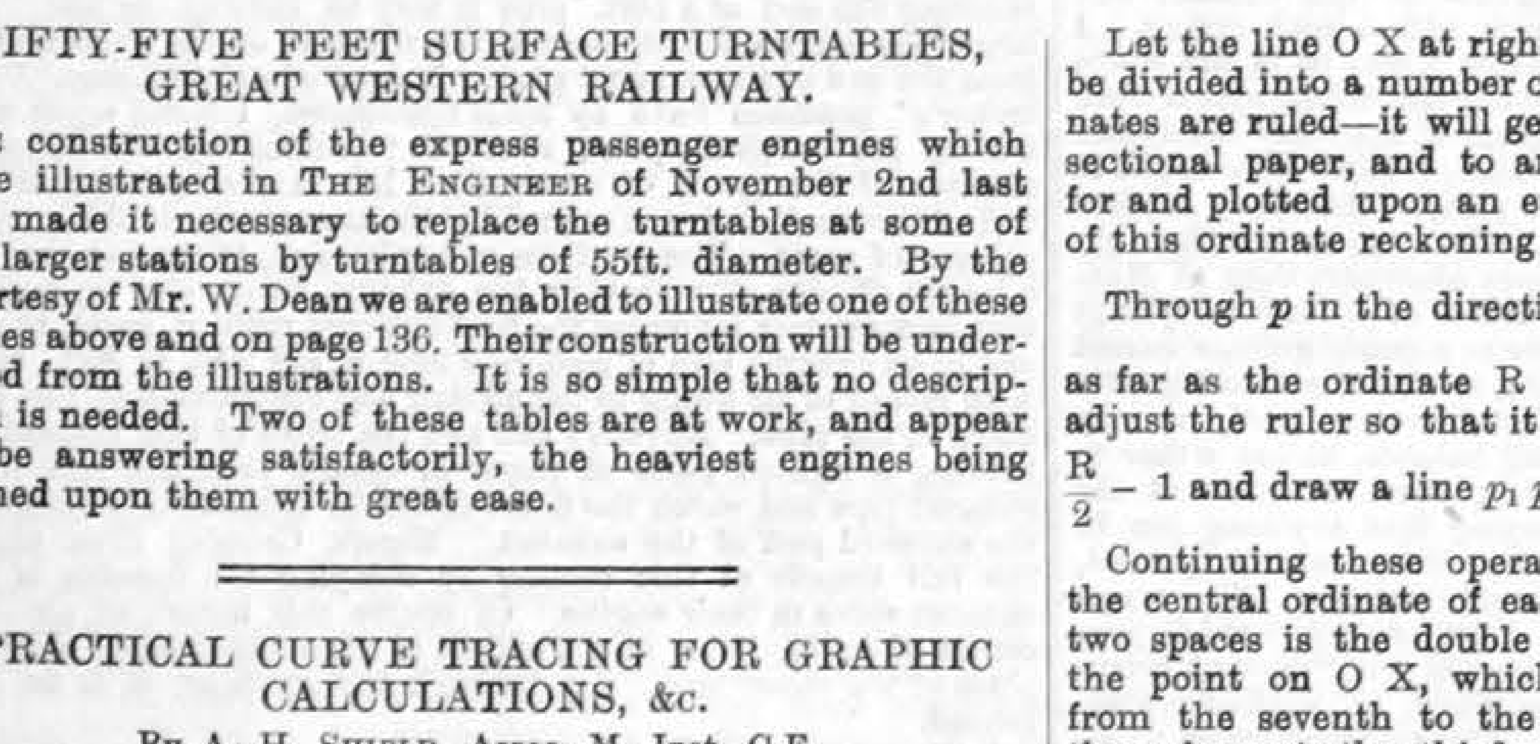
THE construction of the express passenger engines which were illustrated in THE ENGINEER of November 2nd last has made it necessary to replace the turntables at some of the larger stations by turntables of 55ft. diameter. By the courtesy of Mr. W. Dean we are enabled to illustrate one of these tables above and on page 136. Their construction will be understood from the illustrations. It is so simple that no description is needed. Two of these tables are at work, and appear to be answering satisfactorily, the heaviest engines being turned upon them with great ease.

PRACTICAL CURVE TRACING FOR GRAPHIC CALCULATIONS, &c.

By A. H. SHIELD, Assoc. M. Inst. C.E.

IN graphic calculations, and in the preparation of diagrams giving the values of an expression for estimating, or similar purposes, it is frequently necessary to construct parabolas, hyperbolas, and other curves which cannot be drawn by mechanical means without complicated mechanism. To construct such curves by plotting a series of ordinates, or obtaining a number of points by intersecting lines or arcs, and sketching the curve through them, is always a tedious and more or less unsatisfactory process.

Fig 1.



By calculating the highest ordinate of the curve required, and tracing the curve by ascertaining at sufficiently frequent intervals the direction of its tangent, many curves may be drawn continuously with great facility, and with an accuracy which it is difficult to realise without trial.

Take first the curve most frequently required, the ordinary parabola, and let a point p in it be determined from which to the vertex at O it is required to draw the curve.

Let the line O X at right angles to the axis of the parabola be divided into a number of equal parts, through which ordinates are ruled—it will generally be found convenient to use sectional paper, and to arrange that p may be computed for and plotted upon an even ordinate—and let the number of this ordinate reckoning from O be R.

Through p in the direction of $\frac{R}{2}$ on O X draw a line $p\,p_1$ as far as the ordinate R − 1. Without lifting the pencil adjust the ruler so that it cuts the line O X at the ordinate $\frac{R}{2} - 1$ and draw a line $p_1\,p_2$ as far as the ordinate R − 3.

Continuing these operations, and bearing in mind that the central ordinate of each short tangent passing through two spaces is the double in order of that passing through the point on O X, which the ruler cuts, *e.g.*, in ruling from the seventh to the fifth ordinate through the sixth the ruler cuts the third, a series of short tangents will be obtained which finally run into O X at the first ordinate. By making the tangents short the approximation to the curve may be made as close as is desired, but the operator will find, in practice, a limit beyond which it is undesirable to shorten them on account of the tendency to a microscopic rise of the pencil at each stopping point. Moreover, in inking in the curve, by smoothing off the slight angles in the right direction, an almost perfect curve can be obtained. The necessary check on the accuracy of the work can readily be made, as the ordinate at $\frac{R}{2}$ should be exactly one-fourth of the plotted ordinate p.

Having described in detail the method of operation in the case of the ordinary parabola, it remains to show how the direction of the tangent can be obtained in the case of other curves.

If $y = c\,x^n$ is the equation to the curve, and d the distance of the intersection of the tangent from 0, the origin of co-ordinates,

$$\frac{d\,y}{d\,x} = n\,c\,x^{n-1}$$

$$d = x - \frac{y}{\frac{d\,y}{d\,x}} = x - \frac{c\,x^n}{n\,c\,x^{n-1}}$$

$$= x - \frac{x}{n} = \frac{n-1}{n}\,x.$$

Whence for

$y = c\,x^2$; $d = \frac{1}{2}\,x$ as in the previous example.
$y = c\,x^3$; $d = \frac{2}{3}\,x$
$y = c\,x^4$; $d = \frac{3}{4}\,x$, and so on.

Proceeding backwards through a case which, although of no practical utility, serves to illustrate the generality of the principle; for,

$y = c\,x$, $d = 0$, and the curve is a straight line from any point to the origin of co-ordinates.

$y = c\,x^{\frac{1}{2}}$ or $c\,\sqrt{x}$, $d = -x$, and any tangent cuts O X as far to the left of O as its central ordinate is to the right of O.

$y = c\,x^{\frac{1}{3}}$ or $\sqrt[3]{x}$; $d = -2\,x$

$y = c\,x^{\frac{1}{4}}$ or $\sqrt[4]{x}$; $d = -3\,x$, &c.

$y = c\,x^0 = c$; $d = \infty$, and the curve becomes a straight line parallel to O X.

$y = c\,x^{-\frac{1}{2}}$ or $\frac{c}{\sqrt{x}}$; $d = 3\,x$

$y = c\,x^{-1}$ or $\frac{c}{x}$; $d = 2\,x$

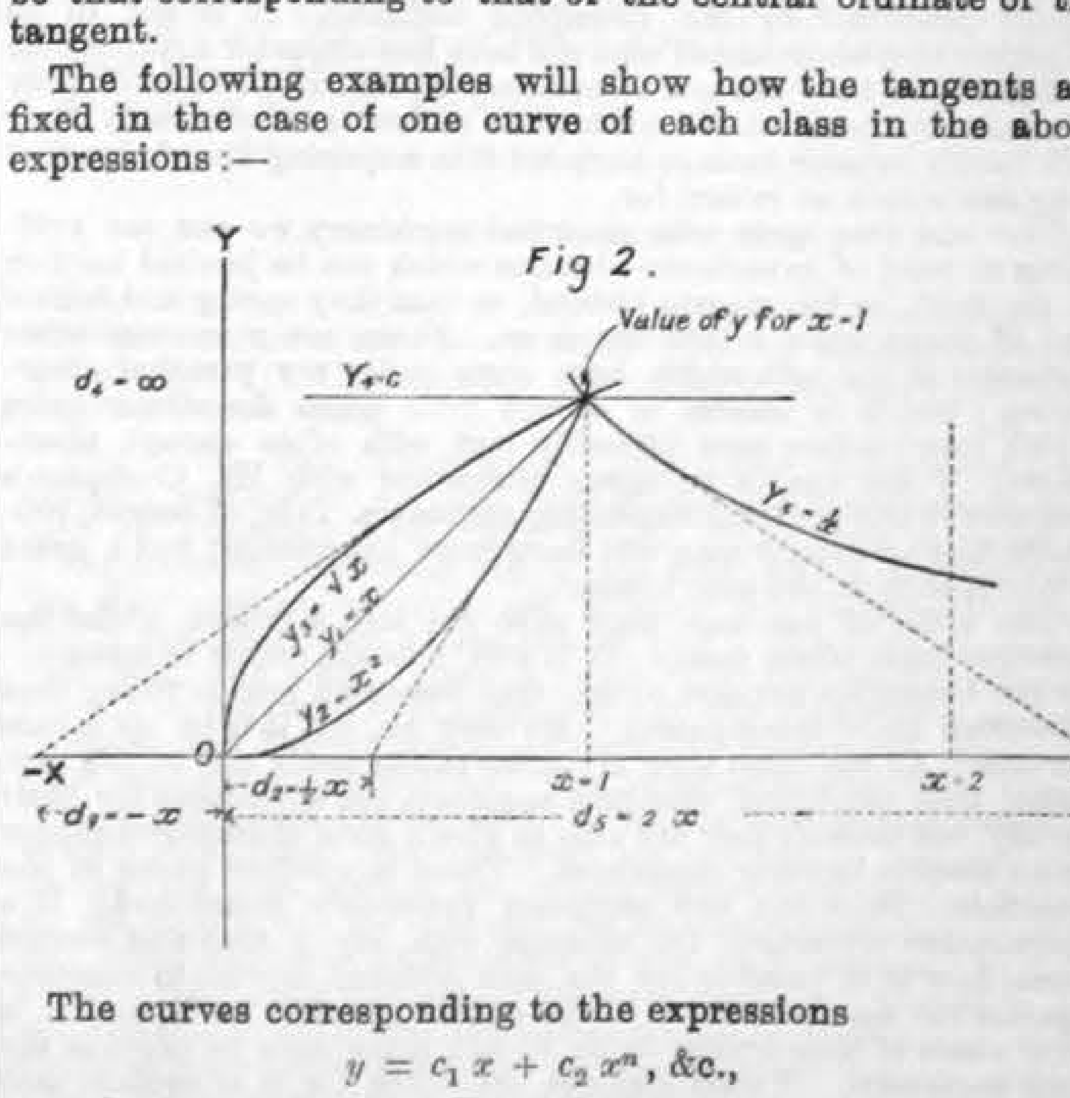
$y = c\,x^{-2}$ or $\frac{c}{x^2}$; $d = 1\frac{1}{2}\,x$

$y = c\,x^{-3}$ or $\frac{c}{x^3}$; $d = 1\frac{1}{3}\,x$, and so on.

In all cases it is to be noted that for the direction of each short tangent, the value of x from which d is calculated must be that corresponding to that of the central ordinate of the tangent.

The following examples will show how the tangents are fixed in the case of one curve of each class in the above expressions:—

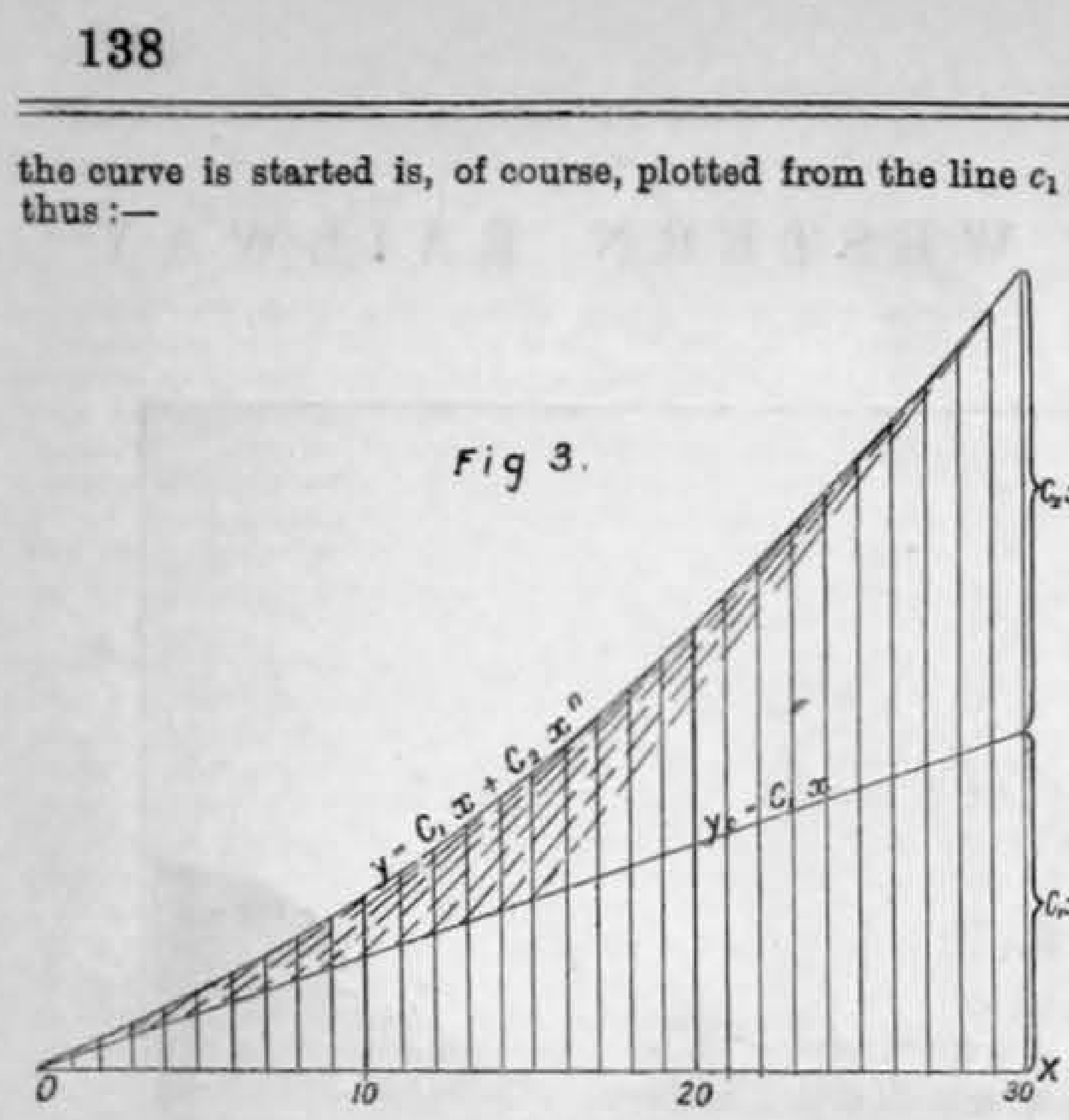
Fig 2.



The curves corresponding to the expressions

$$y = c_1\,x + c_2\,x^n, \text{ \&c.,}$$

may be drawn by first drawing the line $y_0 = c_1\,x$ and then using it in place of the axis O X to determine the direction of the tangents. In this case the value of $c_2\,x^n$, from which the curve is started is, of course, plotted from the line $c_1 x$, thus:—



The limit of the practical application of this method is the adaptability to mental or at least sufficiently simple calculation and plotting of the quotient $\frac{y}{\frac{dy}{dx}}$.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions o our correspondents.)

MODERN ELECTRICITY.

SIR,—I have read your criticism of Mr. Crompton's Presidential Address, in your issue of the 25th, with interest. It appears that one of Mr. Crompton's complaints is that the younger engineers of the present day do not sufficiently study the different methods of obtaining the same results, in use not only in England, but also on the Continent and elsewhere. I would like to ask him, with your permission, how he proposes that the good end should be attained? How is the necessary expense to be borne by an assistant receiving at most 30s. per week, and more often 20s.?

Let Mr. Crompton set about trying to induce engineers to recommend men to berths for their ability and practical knowledge instead of for their social qualifications, and he will be in a fair way to attain his desired end. At present social qualifications appear to be the main thing necessary to get on in any branch of the profession of an engineer; provided that he has the least knowledge of his business, and the usual allowance of ordinary common sense, he will be given a berth in preference to one without the same social standing, but with a thorough, all-round knowledge.

Of course you will understand that I am not intending to say that men with no education should always be appointed to posts in preference to those who have received a gentleman's education, but have not so much practical knowledge as the former. A man may be a mechanic of the highest class, and yet be unfitted for a certain post by reason of his lack of knowledge of the ordinary rules of refined society. Take the case of two boys wishing to "go in for engineering." The parents of one boy cannot afford a large premium to get their son into a suitable works, but have to send him as an ordinary apprentice. Accordingly, after the usual useless—or next to useless—education of a gentleman, he is started at the age of sixteen at six o'clock on a cold winter's morning without breakfast, and working in the usual airy well-ventilated shops of a large marine works, and serves the usual five years, after which he works in the various capacities of journeyman engineer in his own shop, and after a while leaving it and travelling, working as millwright and on various classes of electrical work, not only in this country but also abroad. We will assume that either by private study and attending evening classes, or by a short period in a technical school, he obtains a sound knowledge of the theory and principles of electrical and mechanical engineering. He has also in the course of his fourteen years or so of experience picked up a large amount of useful knowledge concerning bricks and mortar, and repair of breakdowns, and has obtained a knowledge of the world by long experience and roughing it. His age now, we will say, is thirty, and he applies for a berth where he is in competition with his former schoolfellow.

This one is kept at a high-class gentleman's school till he is, we will say, 19. His parents then send him to a high-class firm as a premium pupil at a cost of £300 for three years. He spends a few months in each department, but of course does not leave any department a passable workman; his hours are nine to five, and on arriving home he spends the time in social amusement instead of study. He is fortunate enough to have influence with a certain corporation or large firm, and under the circumstances named, it is nearly a foregone conclusion that the latter will get almost any post in preference to the former.

Over and over again I have known men of little or no experience put over the heads of men with wide knowledge and large experience, and each man socially equal by birth. Yet which of these two men is the best?

If he is not able to get this post, the engineer (?) with money will work for nothing, whilst the engineer of experience will have to walk about with his hands in his pockets. As long as people pay their educated employés starvation wages, so long will the state of affairs described by Mr. Crompton continue. It is not to be expected that experienced men will take less wages for a responsible position than they can get as ordinary mechanics; and until they can see some prospect of an adequate return for their money, they will hardly be such fools as to spend it in acquiring knowledge that they can obtain no return for.

Over and over again with electrical machinery we can see evidences of want of experience—brasses which can be jambed hard on to the shaft, or improperly bedded, so that they spring and buckle out of shape when a load comes on. There are numerous other instances of the sort which have come under my personal observation; but it is useless to occupy your space describing cases which your readers have probably met with often enough themselves. I am unable to agree altogether with Mr. Crompton's remarks *re* the youthful consulting engineers. It is, of course, probable that an elderly man will have more experience; but a great deal depends on the man himself.

The elder of two men may have got into a groove, whilst the younger man starts fresh. It is also, I think, unfair to assume—as Mr. Crompton appears to do—that because a man is young that therefore he is incompetent. He may be, but it is by no means certain. At the same time my observation leads me to the firm belief that consulting electrical engineers are not chosen for their ability, but because they are able to give a good champagne supper to an electric lighting committee. There is another phase of the question. Take the two engineers previously mentioned. If a corporation advertises for schemes with, say, a first and second prize, how is it possible for the man without capital to compete against the man who has it? He cannot possibly do it, and it is only waste of time trying to do it, not being able to provide the time necessary. If such schemes are asked for it is certain that they will be sent in only by large firms, who will only consider the requirements of the district so far as they do not put their machinery out of court. So far as my experience goes, I have observed that in cases where the ordinary run of consulting electrical engineer has been employed, the running of the station is marred by defects of detail. It is not the large or important points that are not considered, but small details.

Some years ago I read an address by, I think, Professor Perry, the key-note being, "Attend to small details." This found an echo in myself, as it tallied so exactly with my own experience. No detail is too small to be noticed; the addition of a well-thought out detail to a machine may save pounds in the end.

To sum up: If Mr. Crompton wishes to get men with experience, let him pay them a fair salary. Men cannot live on air, nor is engineering ability confined to premium pupils, as is so often assumed; I was almost adding rather the reverse. G. P.

Littlehampton, February 9th.

LIQUID FUEL.

SIR,—We have read with interest the article on the above subject in your issue for 18th ultimo. The theoretical value of oil fuel is about 21,000 thermal units against an average for coal of about 14,500, but it is with the practical value that we have to deal, and in practice 1 lb. of oil fuel is found to equal 2 lb. of coal. With a coal fire, not only are the intervals of firing, with the consequent opening and closing of the fire-door, &c., detrimental to economy, but the "green fire" freshly put on must burn through before good combustion ensues, whilst the slow distillation of fresh coal absorbs heat from the incandescent base, which heat is wasted as the gases pass through the tubes unconsumed, with the result of coating the interior of the tubes with a deposit of soot.

A still greater economy arises from the ease with which an oil fire can be regulated to meet varying requirements, avoiding the waste of steam which occurs with a coal fire at every temporary reduction in the demand for power. We append results furnished to us by Mr. Holden from the continuous running of four express locomotives of identical build on the Great Eastern Railway for eight weeks, during which time the fuel used—liquid and solid—was accurately weighed and measured, and the engines worked the same trains in turn. On two of these engines petroleum residue—Astatki—and coal have been burnt in conjunction on Mr. Holden's system; on the remaining two coal only as usual.

The following are relative values of oil fuel and coal deduced from the results obtained in running four express locomotives of same class for eight weeks from November 18th, 1894, to January 12th, 1895:—

Class of Engine: Standard Four-coupled Express; cylinders, 18in. *by* 24in*; drivers,* 7ft. *diameter.*

Fourteen days ending.	Two coal burners.		Two liquid fuel burners.				Lbs. of oil replaced lb. of coal.	Value of oil compared with coal.
	Miles run.	Consumption, lb., per mile.	Miles run.	Consumption, lb., per mile.				
				Coal	Oil.	Total		
1894. Dec. 1st..	3419½	33·94	3423¾	12·22	10·04	22·26	10·04 lb. replaced 21·72	2·2
„ 15th	3185½	33·76	3411½	12·13	9·10	21·33	9·10 „ 21·63	2·4
„ 29th	3332	35·14	2854	11·90	11·06	22·96	11·06 „ 23·24	2·1
1895. Jan. 12th	3423	35·70	3174	13·00	11·40	24·40	11·40 „ 22·70	2·0
Average & totals.	13360	34·64	12863	12·31	10·40	22·71	10·4 lb replaced 22·33 lb. of coal.	2·18

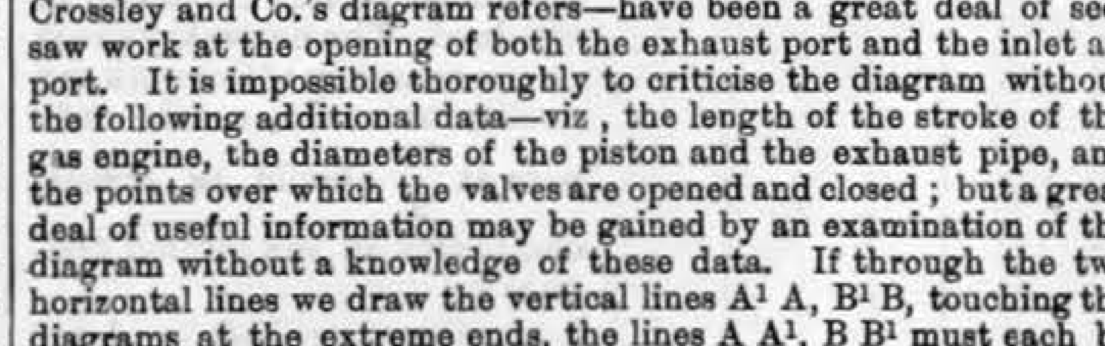
TAITE AND CARLTON.

63, Queen Victoria-street, London, E.C.,
February 8th.

EXHAUST FROM GAS ENGINES.

SIR,—Messrs. Crossley and Co. have anticipated your correspondent's suggestion to take a diagram of the exhaust and charging strokes of the scavenger engine with a weak spring. I fully expected that the reply to my letter would be in the shape of a gas engine diagram, but certainly not one taken with a weak spring. As they must have had a diagram of the compression and expansion strokes taken at the same time, I think they ought to have shown the whole diagram, not a part, so that your readers might have seen the effect of the use of the weak spring throughout the whole cycle. Practical engineers elsewhere than at Manchester know that the sudden application of a load to springs causes them to compress and elongate to a much greater extent than would be caused by the application of the same load gradually applied. Every butcher knows that however lightly he may place his joint in the scale of the spring balance, he has either to wait until the oscillations of the spring cease or guess at the weight. "Bibcock" is wrong in asserting that anything can be proved by mathematics. Only one of two things can be proved, either the truth or the errors of the mathematician. The errors may be of two kinds, either errors in mere analysis—which your correspondence columns prove to be nowadays of frequent occurrence—or errors in the assumptions on which all applied mathematical investigations necessarily rest. The assumptions on which the equations given in my last letter rest do not represent even approximately the actual facts of the case, but they do give a fair equivalent of the actual facts. If anyone feels inclined to challenge the correctness of this statement, I am quite ready to take up the challenge.

Now it can be proved that a load suddenly but quietly applied without impulse to a spring causes it to extend or contract to double the extent which would be caused by the gradual application of the load. The sudden application of a load, the gradual of which would cause a contraction of ¼in. in a strong spring and 1in. in a weak spring, would cause a contraction of ½in. in the former and 2in. in the latter. For this reason no reliance can be placed on the indicator diagrams of gas engines subject to explosive pressures. There must in the original diagram—to which Messrs. Crossley and Co.'s diagram refers—have been a great deal of see-saw work at the opening of both the exhaust port and the inlet air port. It is impossible thoroughly to criticise the diagram without the following additional data—viz., the length of the stroke of the gas engine, the diameters of the piston and the exhaust pipe, and the points over which the valves are opened and closed; but a great deal of useful information may be gained by an examination of the diagram without a knowledge of these data. If through the two horizontal lines we draw the vertical lines A^1 A, B^1 B, touching the diagrams at the extreme ends, the lines A A^1, B B^1 must each be equal to the length of the stroke. A B clearly represents the



atmospheric line, and as nothing is said about the meaning of A^1 B^1 I can only conclude that it represents the final pressure on the opening of the exhaust port. In order to arrive at the true indicated horse-power of ordinary gas engines working with the Otto cycle it is necessary to deduct from the area enclosed between the curves of compression and expansion the area between the curves marked on the diagram during the exhaust and receiving strokes, because this area represents work done in the cylinder by the energy of the fly-wheel. This corresponds with the work done in forcing air and gas into the cylinder in the case of engines which have an explosion at every stroke. In the case of the scavenger diagram, if the curve *e m n o* is really produced as Messrs. Crossley Brothers suppose, we have to add the area A *e m n o*, and deduct the areas A *o m e* and B^1 *c d m* B. In accordance with the diagram, there is not for a short interval from the point B^1 any change of pressure. If, therefore, the line B B^1 represents the pressure at the opening of the exhaust, the exhaust port cannot have been opened till after the commencement of the exhaust stroke. We have next a sudden drop down to the atmospheric line, and a rise to a maximum about the middle of the stroke. Since the actual pressure in the interval can never have fallen below this maximum, the dip must be due to the sudden release of the pressure on the spring by the opening of the exhaust port. Beyond *t*, the point of maximum pressure, we have again another dip below the atmospheric line. This sudden dip can only be due to the opening of the inlet air valve. Previously to this the whole of the exhaust gas had to be forced through 60ft. of pipe, subsequently it had only to be forced through the inlet air valve. That this sudden drop in the pressure is due to the opening of the air valve is proved by the line of pressure *o m* at the commencement of the return stroke being above the line *o n m*. If the lowest pressure reached during the exhaust stroke were due to the momentum of the exhaust gas in the 60ft. pipe, a still lower pressure would have been reached at the commencement of the return stroke, because the vacuum is increased by the motion of the piston. If Messrs. Crossley and Co. will keep the inlet air valve closed during the whole of the exhaust stroke, they will find the curve of pressures from the point *d* to the end of the stroke never falls below the atmospheric line. Not the least curious feature in the diagram is the form of the curve during the inlet stroke from the point *m* to the point B after the exhaust port has been closed. The case is now on all fours with that of an ordinary Otto engine, in which the amount of vacuum varies with the speed of the piston, so that the lowest pressure is reached at midstroke, and the rise in pressure from midstroke to B is continuous. In the diagram the lowest pressure appears to be reached between midstroke and the point B, at which there is a sudden rise. What can be the meaning of the horizontal waves in the curve of compression at the point *e*? It seems clear that the diagram records the vagaries of the weak spring, not the variations of pressure in the cylinder.

Messrs. Crossley and Co., however, stand on solid ground when they rest their claims to increased efficiency on the results of the test by metre and brake. All they have to do to establish their position is to convince buyers that they can get one brake horse-power per 16½ cubic feet of gas per hour. It does not matter what may be the true explanation of the increase. ONLOOKER.

February 5th.

SIR,—The reply of "Bibcock" and Messrs. Crossley Bros. to "Onlooker's" letter still leaves the question of how the reduction in the consumption is effected, where it was. To begin with, it must be granted that this economy does exist in Messrs. Crossley's development of the "Otto" engine. "Onlooker's" chain of reasoning would no doubt be correct had his premises, or rather assumptions, been so. Let us examine them. "So long as the exhaust gas retains its temperature the velocity will be the same at every point in the column of moving gas." Immediately the exhaust valve is opened the temperature rapidly falls, and, whether the temperature fell or not—"Onlooker" forgets the elasticity of the fluid we are dealing with—the velocity could never be the same. The charge, on passing the exhaust valve, begins to compress the gases immediately in front against the inertia of the column beyond, and this compressed area passes rapidly up the tube until the whole column is in motion. The next assumption of "Onlooker's" is manifestly incorrect, and the equations upon it equally so. "Onlooker" bases his equation upon a column of carbonic acid gas at 300 deg. Fah. being equal in weight to a column of air at 60 deg. Fah. of the same height. Now what can this have to do with it? Firstly, a very large proportion of the exhaust gases is steam; and secondly, the volume of carbonic acid gas contained in the exhaust is continually cooling and condensing, and while it may, on leaving the exhaust, be 400 deg. Fah., on reaching the end of a 50ft. pipe it may be 100 deg. or less. The larger the engine the higher the temperature of the gases issuing from the end of the exhaust pipe. Nevertheless, although "Onlooker's" premises have so little foundation, I quite agree with him in his conclusion, *i.e.*, that the "sucking up the chimney of some of the gases of combustion left in the cylinder at the end of the stroke" is not caused by the momentum of the moving column of gases. The products of combustion, in passing through a length of pipe after leaving the exhaust valve, cool so rapidly that immediately following the first outward rush of gases at the end of an exhaust pipe of moderate length, say 20ft. to 30ft., there is an inrush of air owing to the cooling and contraction of the products in the pipe. Anybody can test the truth of this himself by holding a lighted piece of paper or candle near the end of an exhaust pipe and watch the flame streak in immediately following the outward puff of the exhaust. Messrs. Crossley Bros. obtain the full benefit of this cooling by delaying the opening of the exhaust valve in their engine. Of course this inrush of air—the centre of cooling being at the middle of the exhaust pipe—will take place at the other ends, *i.e.*, through the cylinder, if it be permitted.

In the winter of 1888 I had a four-stroke cycle engine running and working satisfactorily with all the products cleared out in this way and with the exhaust valve opening at the stroke end. Indeed, since that time I have frequently disregarded in adjusting an engine the usually accepted rule, as to the time of closing the exhaust valve in the four-stroke cycle engine, and frequently with benefit to the brake power.

I must confess, however, that the engine referred to, upon which I spent much time in November and December, 1888, and January, 1889, gave no better results as to consumption than the ordinarily adjusted Otto, and not so good a result as the engine I subsequently manufactured. These experiments led me to a more ambitious attempt in the following month, viz., the using this cooling process to do practically the whole work of suction, a description of which will be found by anyone interested in this subject in patent specification 3972, March 6th, 1889. This engine worked fairly well, but was less reliable than the four-stroke cycle, and I ultimately abandoned it. Nevertheless it was a beautiful experiment, one of those theoretically, ideally perfect things that practice could not be persuaded to endorse, though some day it may, and Mr. Atkinson's success is a step in that direction. J. D. ROOTS.

February 3rd.

LOCOMOTIVES AND TRAINS.

SIR,—I dare say the following particulars will be interesting to those who are disposed to question the capabilities of the modern locomotive. The *Railway Engineer* for January last, says in reference to the Jeanie Deans compound, London and North-Western Railway:—

"In October, 1891, we stated that her average consumption for 51,916 train miles was 31·9 lb., including 1·2 lb. per mile for raising steam. The train worked was the 2 p.m. ex Euston, and the average weight of it would be then about 230 tons, and the train is timed at 52·5 miles per hour on the down journey, and 51·6 miles per hour on the up. The Jeanie Deans has continued to work this train, though since the corridor carriages have been put on, the weight of the loaded carriages has gone up to about 277 tons, while the speed has remained the same, and the consumption has not appreciably altered. We know of no other engine in the world which has done such good work, but it is only just to observe that the other engines—the Greater Britains—have never had the chance. The Greater Britain class have larger boilers, and are more economical than the Jeanie Deans class."

I have frequently seen this train at Tamworth, or Lichfield, Stafford, and Crewe, and it has always been up to the minute;

and on one occasion it had on twelve corridor coaches, so that the total moving weight must have been from 350 to 380 tons, with only Jeanie Deans on. This could not possibly have been worked by the ordinary coupled Precedent class of engines, unaided.

The following particulars of a run with this train from Crewe to Penrith in October, 1893, may be interesting as showing some good work. The 51 miles from Crewe to Preston were done in 63 minutes—65 allowed—including two bad slacks up a bank of 1 in 105. After Preston we still had ten corridor coaches and no pilot. Some time was lost here by station work.

Miles.	Chains.			Time	
—	—	Preston	dep.	6.47 p.m.	10 minutes late.
4	61	Barton	pass	6.55 p.m.	Uniform speed of 60 miles per hour.
				h. m. s.	
20	52	Bolton-le-Sands	„	7 15 30	
1	66	Carnforth	„	7 17 25	Average speed 41·7 miles per hour.
4	41	Burton and Holme	„	7 22 30	
2	58	Milnthorpe	„	7 25 25	
5	45	Oxenholme	„	7 32 30	
7	19	Grayrigg	„	7 44 20	
5	67	Tebay	„	7 51 50	
5	40	Shap Summit*	„	8 3 0	
2	10	Shap	„	8 5 40	Speed 70 miles per hour.
7	22	Clifton	„	8 12 15	
4	17	Penrith	stop	8 16 15	10¼ min late.

* The last mile up Shap was at the rate of 26 miles per hour.

The average speed from Preston to Penrith was 48½ miles an hour, or according to booked running time. The engine was the Gaelic, sister engine to the Jeanie Deans. I do not know much of what modern engines are doing on other lines, but I am sure these must be a cause of satisfaction to the locomotive department on the London and North-Western Railway. SYDNEY SHEDDEN.

5, Belvidere-road, Walsall, February 11th.

SIR,—I venture to doubt whether the re-timing of the Midland express is due to the correspondence in your paper, as Mr. Stretton suggests. The more natural explanation is that the train has now a conditional stop at Luton for Glasgow passengers, and is therefore allowed three minutes longer. So again, if the 3 p.m. is to stop every day now at Wellingborough, instead of on Mondays only as formerly, it is natural to give the train an extra minute or so for the run. A. WARBURTON.

Eastbourne, February 11th.

THEORY OF THE STEAM ENGINE.

SIR,—I am astonished that Mr. Cross has found my letter in your issue of February 1st so difficult. I am of opinion that most of his difficulties are subjective. He is somewhat unreasonable in having doubts about my results because he cannot find the subject developed in Rankine, Clerk-Maxwell, or Clausius, as his expressed reason for applying to me for explanations was that he could not find any in the works of these writers. As far as I am aware, the subject has not been developed before, but not being widely read in articles and letters in periodicals, I will not be positive. Perhaps some other correspondent can tell if I am right in my conjecture. But in any case it is all new to me. I have built it up entirely from data given in tables at the end of Cotterill's "Steam Engine considered as a Heat Engine." These data were given by Regnault as the results of his very brilliant and exhaustive series of experiments on steam. I found Cotterill's statement of these results more suitable for my purposes than those in other works. Mr. Cross and others who read my letter can see for themselves if I have made a logical use of these data. If so, Regnault is at fault if the conclusions I have derived from them are not true.

Taking up Mr. Cross's difficulties in detail. First, his difficulty about the two varieties of latent heat not having been mentioned in the books spoken of. He will find a distinct statement on the matter in Clausius, § 6, page 27, Browne's translation. He will also find a very definite statement on the subject on page 91 of Peabody's "Thermodynamics of the Steam Engine." But apart from these Mr. Cross can see for himself that there are two resistances opposed to the separation of the molecules of water while changing into steam, namely, an internal resistance due to the attractions of the molecules on each other, and an external resistance opposed by external matter to the expansion of the water into steam. Surely Mr. Cross did not suppose that I was ignorant of the fact that what is called latent heat is not heat at all? If not, why his long disquisition on this subject? Also what does he mean by saying that "there is no such thing as 'latent' heat?" Also what does Mr. Cross mean by saying that I ignore this theory—what theory?—altogether and give nothing in its place? As regards Mr. Cross's second difficulty, can he not see that the two forms of energy possessed by the steam are mutually convertible—that is, sensible heat—which *is* heat—can become latent heat—which is not heat, but some other form of molecular energy—under suitable circumstances, and that latent heat can become sensible when these circumstances are reversed?

In his third difficulty he makes a quotation from my letter, and seems to try to twist my words from their natural meaning by taking them apart from the context. He also draws an inference from them which cannot be legitimately drawn from them, namely, that sensible heat and temperature are two quite different things. I do, however, assert the truth of this statement *now*, although I deny it to be deducible in a straightforward way from my words quoted by Mr. Cross. To prove the truth of this statement it is only necessary to state a simple fact, namely, that 1 B T U. added to a pound of water will raise its temperature 1 deg. Fah., but if added to 2 lb. of water it will raise the temperature only ½ deg. Fah. The words quoted taken with the context say that while a pound of saturated steam of temperature ·358 deg. Fah. is changing to a pound of saturated steam of temperature ·359 deg. Fah. it acquires 1 B.T.U. of sensible heat, and at the same time loses ·695 B.T.U. of latent heat, which is only approximately true, as I have pointed out in my last letter, where I have said that the 1 B T.U. of sensible heat gained should, to be quite accurate, be 1·037 B.T U., and the ·695 B.T.U. of latent heat lost should be ·732 B.T U. These tables at the end of Cotterill will show Mr. Cross that the latent heat of saturated steam at 358 deg. C. is 860·748 B.T.U., while that of a pound of saturated steam at 359 deg. Fah. is 860·016 B.T.U.; so that a pound of saturated steam in passing from 358 deg. Fah. to 359 deg. Fah., still saturated, loses ·732 B.T.U. of latent heat. These numbers are all total latent heats, including internal and external latent heats.

Mr. Cross's fourth difficulty shows that he has not studied my letter with sufficient care. It is not true, and I have not in my letter said so, that the sensible heat gained by a pound of saturated steam at 358 deg. Fah. in changing to a pound of saturated steam at 359 deg. Fah. is dynamically equivalent to the work which must be done in compressing it. What I have said is that the work of compression generates directly in the steam ·942 B.T.U. of sensible heat, and indirectly it causes the steam to acquire ·733 B.T.U. of sensible heat at the expense of its internal latent heat, by causing its molecules to go closer together, while at the same time ·675 B.T.U. of sensible heat must be drawn off from the steam to keep it saturated. Otherwise it would become supersaturated. Of course, the numbers ·733 and ·675 should be ·676 and ·581, as I have said in my last letter.

Mr. Cross next goes on to talk of steam under constant pressure, saying that he understands ·305 B.T.U to be its specific heat in these circumstances. But ·238 is well-known to be the correct value.

Lastly, Mr. Cross says that I take no account of the fact that steam when compressed over water begins to liquefy when compressed to a certain point. I would remind Mr. Cross that I have all through been dealing with a pound of dry saturated steam.

If Mr. Cross really desires more information, I shall be glad to answer one definite question at a time. But if his object is to lead me into wars of words, "I'll none of it."

My next letter shall be an attempt to answer Mr. Cross' difficulties expressed in his "finally." I hope, therefore, that Mr. Cross will abstain from proposing more difficulties till the said letter appears.

26, Smith-street, Hillhead, Glasgow, PETER ALEXANDER.
February 11th.

KINETIC THEORY OF GASES—AVERAGE TIME OF IMPACTS.

SIR,—The following is another method, to that already given, by which the time of direct impact of an elastic sphere against a fixed plane can be found:—

The pressure against unit surface of a fixed plane by the impact of elastic spheres is given by the equation $p = \frac{1}{3}\rho \bar{v}^2$, and this may be written

$$p = \tfrac{1}{3} m n \bar{u}^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where p is the pressure, m the mass of each sphere, n their number in unit volume, and $\bar{u}$ their mean velocity normal to the plane.

Again, the pressure against unit surface of a fixed plane must obviously be due to the actual number pressing against it at any instant. Let this number equal k, then

$$p = \frac{k m \bar{u}}{t} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

in which equation p, m, and u have the same values as in (1), and t is half the time of impact, or the time in which the momentum $m\bar{u}$ is destroyed. Combining (1) and (2) we get

$$t = \frac{2k}{n\bar{u}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Now, k being the number of spheres in contact with unit surface of the plane at any instant, is obviously the number in a lamina of unit area and thickness d the diameter of a sphere. But in unit volume there will be $\frac{1}{d}$ such laminæ, and each of these will contain k spheres. Hence, the total number of spheres in unit volume will be $\frac{k}{d} = n$, and therefore $k = n\,d$. Substituting in (3)

$$t = \frac{2d}{\bar{u}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where t is half the time of impact. Putting $2t = \mathrm{T}$ the total time of impact—

$$\mathrm{T} = \frac{4d}{\bar{u}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Owing to my having inadvertently made use of the expression $p = \frac{n\,m\,\bar{u}}{t\,l^2}$ for the pressure against the *whole* surface of the plane, instead of $p = \frac{n\,m\,\bar{u}}{t}$, in finding the time of impact, in my letter of December 7th, the result obtained therein is incorrect; but by making the correction indicated it will be found to agree with the above equation.

Equation (5) gives the time of direct impact against a fixed plane, and since an impact of this nature is equivalent to a direct impact between two spheres moving with equal velocities in opposite directions, the time of direct impact between two equal spheres will be given by the equation

$$\mathrm{T} = \frac{4d}{\frac{1}{2}(u - v)}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where u and v are the velocities of the spheres, v being positive or negative according to its direction relative to u.

The above equation also gives the time of oblique impact between two spheres, u and v in this case being the resolved velocity of the spheres in the line joining their centres at the moment of impact, *provided* that the other components of the velocities do not separate the spheres before the time of impact due to compression and restitution is completed. From this last consideration it is obvious that for any particular value of $(u - v)$ in (6) that equation only gives the maximum time of impact, and the actual time may be anything between this maximum value and zero, the mean time being $\frac{1}{2} \times \frac{4d}{\frac{1}{2}(u - v)} = \frac{4d}{u - v}$. To find the *average* time of impact it is now only necessary to find the mean value of $(u - v)$. For this purpose we may suppose the whole of the spheres within the volume considered to be moving in every direction with their mean velocity $\bar{v}$. In this case the maximum value of $(u - v)$ in equation (6) becomes $2\bar{v}$, and it can have every possible value between this and zero, hence its mean value will be $\bar{v}$. Substituting this value of $(u - v)$ in (6) and putting $\overline{\mathrm{T}}$ for the average time we have—

$$\overline{\mathrm{T}} = \frac{\frac{1}{2} \times 4d}{\frac{1}{2}\bar{v}}$$

or

$$\overline{\mathrm{T}} = \frac{4d}{\bar{v}} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

This value for the average time of impact makes the probability of three or more spheres colliding simultaneously to be so great—when the numbers of the spheres in unit volume and their diameters are approximately the same, as is supposed to be the case with gases such as oxygen, for example, at standard pressure and temperature—that it seems to me absolutely necessary to take it into consideration in the study of the dynamical foundations of thermodynamics.

The probability of a third sphere impinging against two in collision will be given by the ratio of the average time of impact to half the average time of free path. It will be to half the time of the latter, because two spheres occupy twice the volume of a single one. The average time of contact, as we have just seen, is $\frac{4d}{\bar{v}}$; and in my letter of January 4th, the time of free path was found to be $\frac{1}{4\,n\,\bar{v}\,d^2}$.

Hence the probability is given by the ratio $32\,n\,d^3$. In the above-mentioned letter—page 7—the value of d^2 for oxygen was found to be probably $\frac{450\,000}{4\,n}$; this would make the above ratio about $\frac{72}{1000}$.

In other words, we may expect on the average that in every thousand collisions there will be seventy-two occasions in which three or more spheres will be in simultaneous collision. The value of n in the above calculation is taken at 3×10^{20}.

8, Norfolk-square, London, W., C. E. BASEVI.
February 1st.

LABOUR AND LUXURIES.

SIR,—As I was about to allege an insufficient acquaintance among financiers with the pages of THE ENGINEER to be an important cause for the at present accentuated dissociation of labour and luxury, I suppose I ought to consider the appearance of letters from such a centre as "Capel Court" a hopeful sign. But the supposition that the crisis in the United States conflicts with my argument, does not suggest that the proverbially short views and shorter outlook of the Stock Exchange have yet been exchanged for the wider outlook of THE ENGINEER. For if gold alone could maintain the credit of any country, that country assuredly is the United States, the largest producer of gold in the world. The way in which the Government sets itself to dissipate the surplus in the treasury and defy all dictates of sound finance, is no doubt instructive, but is a little beside the present question, after we have noticed that the remitting depression there is a cause of depression here, obvious even to those who, at the outset, urged us to follow their specious example. I venture to suggest that Newfoundland would have served "Capel Court's" purpose better, for at all events the retort is less obvious, the facts are less patent.

My main quarrel with "Y. X." has been that he gets his problems into an impracticable form. He presents us with something resembling the old "wages fund" theory, which it is now agreed leads nowhere, with the added fallacy that whereas the fund was taken to consist of consumable articles, he apparently limits it to money, with the result—common in American politics—that depression is ascribed to a shortness in the circulation, and a remedy sought in an enlarged currency—*cf.* Jevons' "Money," page 334. The question how best to spend £100,000,000 additional gold is simply unanswerable, and to my mind meaningless; but a very slight study of economic history will show that it could not be got into circulation in the country unless there was an enormous and worldwide fall in the value of gold.

The real problem is, not that of spending gold, but of directing to the best advantage the productive forces of the country; that is to say, of employing its labour so as to produce the most ample return. A wide omniscience not being among the attributes of humanity, it is likely that any approximation to this ideal can only be made by each in his sphere attending to his share of the work—minding his own business, in fact; but the share of the honest and capable engineer in the business is no small one, and I imagine that he will not set about to provide employment or to circulate cash, but to accomplish more desirable work, or to put on the market some commodity with the least expenditure of labour and money. Surely this is a distinction with a difference, intelligible to plain business people, apart from our logical madman digging pits to fill up again, and the Lancashire masons tooling over again the quarry wrought steps. Yet, I still opine that an engineer is economically to be preferred to a robber baron, however inferior the engineer may be in point of picturesqueness or generosity, that is æsthetically or ethically.

But for the present it is clear that it is not lack of gold or goods that depresses us, but want of confidence in our industrial leaders, and I venture to think that we shall do better by discussing what engineers can do to restore and maintain the courage of investors than by debating the casuistical line which divides luxuries from necessities, and at which proper, prudent, thrift passes into depressing niggardliness. W. A. S. B.

London, February 6th.

SIR,—Certainly mere change of ownership in land makes no difference to the burden borne by industry. The evil is in the burden itself, amounting in this country alone, according to the careful calculations of Mr. Thomas G. Shearman, to considerably over £200,000,000 a year, of which probably one-fourth is re-invested in further tribute rights. If land were limited in quantity, that would not prevent an unlimited amount of capital being invested in it, though the ultimate effect, after squeezing from industry the utmost amount it could be made to pay, would, of course, be to reduce the rate of interest on such investments, a result which is indeed being slowly brought about through the increasing difficulty found by capitalists in discovering landed properties worth buying. But practically land is unlimited in quantity, as the area of the earth's surface privately owned—by non-workers—is still small; and as new countries are thrown open to exploitation, and population increases in old countries, further enormous outlets for accumulated savings are provided. The rapidly augmenting effectiveness of labour through new inventions, and the spread of machinery all over the world, also increases the tribute-yielding value of land and the amount of capital it can absorb. Money is very far from being limited in quantity, and increases as a rule in proportion to the amount of wealth it represents, though, in consequence of its artificial limitation by the amount of gold in the banks, this proportion is not so exact or elastic as it would be under a more scientific currency. It is only land where population has decreased, for the most part in agricultural districts, that has fallen in value, the rise of values in flourishing cities being phenomenal.

I did not use the term "locking up money." The objection to private property in land is that it enables those who possess it to levy tribute on industry without rendering any equivalent, since the land would be there, and would be just as useful, if landowners had no existence. But the evil resulting from land ownership is not measured merely by the actual rent paid, since, as Mr. Flürscheim has clearly shown in his book, "Rent, Interest, and Wages," it is through the possibility of investing money in land, which is not subject to decay, and which increases in value with growth of population, that other capital is enabled to draw interest. Otherwise it would rather be subject to decrement proportionate to the average depreciation of all forms of true capital, *i.e.*, that which is the product of human effort; and industry, whether devoted to the production of necessaries or luxuries, would obtain its full reward. EVACUSTES A. PHIPSON.

February 5th.

ICE AND WATER PIPES.

SIR,—*Re* your correspondent "Jack Frost's" inquiry headed "Ice and Water Pipes," permit me to suggest the following explanation. A pipe being circular is at its greatest capacity, and cannot increase in area with expansion; consequently it must surrender to any increase in pressure due to ice, causing fracture in its weakest point in the part containing the ice. If only pipes were made elliptical in section instead of circular, the possibility of fracture due to expansion would be greatly diminished, as an ellipse is *not* at its greatest capacity until it becomes circular.

Regent's Park, February 9th. CHARLES L. WILKIN.

SIR,—In answer to your correspondent, "Jack Frost," my own conclusion, based on a large number of observations, is that a pipe bursts because one part of the pipe is probably more exposed than another. The first point A freezes, then another point B, probably a foot or more distant from A, becomes frozen. Now we have two ice plugs in the pipe, with water between them. This, in freezing, tries to expand, and cannot force the two plugs outwards, and as expand it must, the pipe or fitting gives out at the weakest part between the plug of ice. S. M. S.

Winchmore Hill, N., February 11th.

(*For continuation of Letters see page* 146)

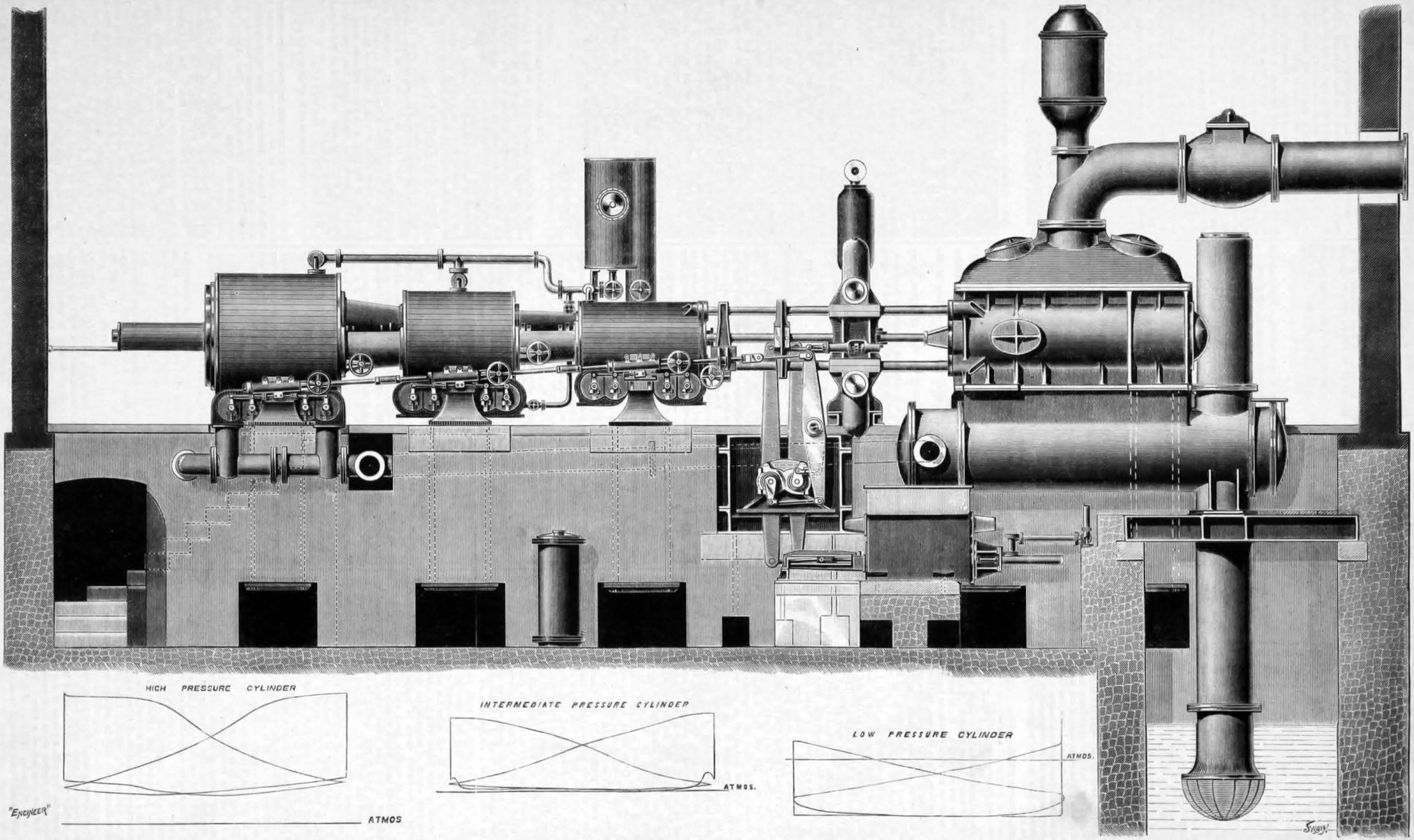
THE ANNUAL DINNER OF THE BIRMINGHAM ASSOCIATION OF MECHANICAL ENGINEERS was held on Saturday evening last at the Grand Hotel, Birmingham. The Mayor presided and the attendance was large.

THE CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—At the ordinary meeting of the Civil and Mechanical Engineers' Society, held on Thursday week, Mr. W. M. Binny read a paper on "Engine-room Practice at Sea." He first gave a description of the chief engineer's duties and those of the second, third, and fourth engineers, both at sea and in port. The type of engines met with, the steam pressure used, and the most economical rates of speed were next gone into, and the advantages and disadvantages of the cylindrical multitubular boilers and the water-tube boilers were alluded to. The troubles arising from the oil from the cylinders getting into the boilers was particularly mentioned, and various methods that are adopted to prevent this. The author then pointed out the importance of having fittings for the boilers that are carefully and substantially made. Mention was made of some of the parts of the main engines that give trouble at sea, and methods of overcoming them. The amount of spare gear and duplicate parts of the machinery that are carried by vessels having been briefly described, and an instance given of how engineers manage when a part of the machinery breaks of which they have not a duplicate, the paper was brought to a close after enumerating some of the packings now used.

TRIPLE-EXPANSION WORTHINGTON PUMPING ENGINE AT HORNSEY SLUICE

MESSRS. JAMES SIMPSON AND CO., LONDON, ENGINEERS

(*For description see page* 131)



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CONTENTS.

TO CORRESPONDENTS.

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

J. B. J.—*Yes. The fans would have a lifting tendency.*

E. W. W.—*The arrangement shown in your sketch will give you a very good draught. Whether the draught will be sufficient for your purpose it is, of course, impossible to say. That depends on the size of the boiler and the actual, not nominal, power you require.*

W. S.—*It is quite impossible to give you any rule for the brake straps of cranes, because the coefficient of friction varies continuously with the conditions of the surfaces, and that depends in turn on the attendant, on the dust in the air, &c. &c. It will not be safe to reckon on a coefficient of friction of more than ·1, and you ought to proportion the brake wheel and strap accordingly.*

E. S. (Lewisham).—*The original design of the Magnificent, as set forth in the parliamentary paper, has been modified. Both pairs of guns, forward and aft, are now to be at the same height above the water-line, viz., 27ft. to centre of metal, or 4ft. higher than the Royal Sovereign. Our engraving on page 8 is correct. That on page 5 shows the original arrangement. The disposition of the 6in. quick-fire guns is to be as represented upon the drawing on page 8 of* THE ENGINEER *of January 4th, viz., eight on the main deck—or four on each broadside—and the other four at the corners of the upper deck battery, making twelve altogether.*

BRICK KILNS.

(*To the Editor of The Engineer.*)

SIR,—Will any of your readers kindly tell me which is the most approved form of brick kiln now in use, and the cost of erection to burn, say, £0,000 per week? Also the makers of the best brick-making machine. A. B.

Hunstanton, February 11th.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, February 19th, at 8 p.m. Paper: "Plant for the Extraction of Gold by the Cyanide Process," by Mr. Charles Butters and Mr. Edgar Smart, Assoc. M. Inst. C.E. Friday, February 22nd, at 8 p.m. Students' Meeting. Paper: "Caissons and Gates for Closing Lock and Dock Entrances," by Mr. William G. Wales, Stud. Inst. C.E. Mr. L. F. Vernon-Harcourt, M.A., M. Inst. C.E., will take the chair.

CLEVELAND INSTITUTION OF ENGINEERS.—Monday, February 18th, at 7.30 p.m., in the Hall of the Literary and Philosophical Society, Corporation-road, Middlesbrough. Paper: "On American Rail and Tramways," by Mr. Jeremiah Head, M.I.C.E. Discussion.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, February 21st, at 8 p.m. Paper: "Propagation of Magnetism in Iron," by Dr. John Hopkinson, M.A., F.R.S., Past-President. Illustrated by experiment

METEOROLOGICAL SOCIETY.—Wednesday, February 20th, at 7.30 p.m., at the Institution of Civil Engineers, 25, Great George-street, Westminster. Papers: "Report on the Phenological Observations for 1894," by Edward Mawley, F.R. Met. Soc. "The Thunderstorm and Squall of January 23rd, 1895," by William Marriott, F.R. Met. Soc. "On some Gradual Weather Changes in Certain Months at Greenwich and Geneva," by Alexander B. MacDowall, M.A., F.R. Met. Soc.

SOCIETY OF ARTS.—Monday, February 18th, at 4 p.m. Cantor Lectures: "Means for Verifying Ancient Embroideries and Laces," by Alan S. Cole. Tuesday, February 19th, at 8 p.m. Foreign and Colonial Section. Paper: "Paraguay," by A. F. Baillie, Consul in London for Paraguay. Lieut.-General Sir Andrew Clarke, G.C.M.G., C.B., will preside. Wednesday, February 20th, at 8 p.m. Paper: "Rule of the Road at Sea," by Admiral P. H. Colomb.

THE ENGINEER.

FEBRUARY 15, 1895.

PRIMING, AND GOVERNING ENGINES.

AT the meeting of the Institution of Mechanical Engineers last week two papers were read and discussed. The first was by Professor Unwin, on "The Determination of Wetness of Steam," and the second by Captain Sankey, on "Governing Steam Engines by Throttling and by Expansion." Professor Unwin added little or nothing to his British Association report, which was reproduced in our impressions for Aug. 24th, and Sept. 7th, 1894. It is, therefore, unnecessary to publish in our pages the paper he read last Thursday week. In the discussion which followed many speakers took part without elucidating an obscure subject to any extent. Nothing has been proved except that it seems to be next to impossible to measure, we will not say with any accuracy, but with any certainty, the percentage of water in any sample of steam. It is not a matter of much difficulty to ascertain the proportion of water present by the tub method, for example; but no one can be sure that the steam passed into the tub fairly represents the quality of all the steam leaving the boiler. It may perhaps be said that the best plan is to trust to the indications of the steam separator, a suitable allowance being made for loss by radiation through the lagged or otherwise clothed steam pipes. If, for example, a salt test result represents one per cent. priming while the separator close to the engine collects 14 per cent. of the feed-water, the steam pipe not being very long, and very carefully clothed with asbestos, then it may be taken as settled that the salt test is worthless. The old question of the specific heat of steam turned up again. It begins to appear that no one knows what it is. According to one view, urged by Mr. Cross in our correspondence columns, it is ·305. Professor Unwin takes it at 0·48. Mr. MacFarlane Gray cannot quite make up his mind as to what it is. Professor Alexander and Mr. Donaldson tell us that it is equal to that of water. It does not help matters much that all deal with steam under different conditions of temperature and pressure and behaviour while being heated, so long as they suffer us to remain in doubt as to what are the conditions presupposed to exist. Again, Professor Unwin tells us that it is impossible to measure the temperature of superheated steam, a statement which we take it for granted implies that the difficulty lies not with the thermometer, but in telling whether the steam is really superheated or not. If we were quite certain that any isolated volume of steam was really quite dry to begin with, it would be easy enough to determine its temperature of superheat; but if the steam contains any moisture at first, this will first be converted into steam, with a rise in temperature and pressure, although the steam has not yet attained the condition of a gas. To sum up, the principal value of Professor Unwin's paper lay in the fact that it teaches us not to accept any statements concerning the dryness or wetness of steam without extreme caution. So far no quite satisfactory method of ascertaining the dryness factor has been devised, and of the various methods in use not one can be regarded as uniformly trustworthy.

Captain Sankey's paper is a very clever treatise on a subject badly taught and ill-comprehended. To the professor of engineering the be-all and end-all of a governor is to maintain as constant a speed of the engine as possible. But Captain Sankey shows that practice teaches us that something more than this has to be considered, and that a system of governing which will answer very well with a condensing engine may not be at all the best for a non-condensing engine. He compares the two systems of governing by a throttle valve and governing by expansion gear, which, as he very pertinently points out, represent in the first case working with a variable pressure and a constant grade of expansion, and in the latter governing with a constant pressure and a variable ratio of expansion. We are glad to find that Captain Sankey holds in the main opinions which we have many times in years gone past expressed in these pages. There is, under certain conditions, no advantage to be gained by governing by expansion gear instead of by the throttle valve. When the variations in power are small in amount, then there is nothing to be got in economy of fuel by using expansion governing. When the variations are very great and frequent, then there is a small advantage derived from varying the point of cut-off, keeping the pressure constant. On one or two points, however, we do not quite agree with Captain Sankey. Having stated a particular case to illustrate his remarks, he went on to say:—"This points to the fact that expansion governing tends to reduce the number of engines required in an electric-light central station; in other words, it can better be afforded to overload engines with expansion governing than engines with throttle governing, for in the former event the economical ill effects of the overload are temporary, while in the latter they are permanent. On the whole, therefore, it can be stated that for large central electric-light stations, when working non-condensing, throttling is as good as expansion governing; but when condensing, governing by the cut-off has a superiority." Captain Sankey has obviously overlooked the circumstance that in electric-light work it is very easy to combine an expansion gear such as Meyer's with a throttle valve. Thus it is possible, without stopping the engine, for the attendant to reduce the ratio of expansion from time to time as the load augments, until in "the bad half-hour" a single-cylinder engine may be working almost without expansion, and a compound engine with the least possible, and under these conditions the throttle valve governor will be more economical than an expansion governor, because throttling always promotes economy by drying the steam, and this economy is independent of the expansion, while, on the other hand, when expansion nearly vanishes because the engine is really overloaded, nothing is to be expected from automatic variations in the point of cut-off. It is noteworthy that few data have been supplied to the world showing that an engine with a variable expansion gear and a variable load has proved more economical than an engine working with the same average ratio of expansion and a throttle valve. It is quite true that very splendid results have been obtained with Corliss engines which are governed by expansion. But an examination of the experiments producing the splendid results shows that the engines were so uniformly loaded that the governors have had next to nothing to do. A very careful distinction indeed should be drawn between cases in which the governors really have a great deal of work to perform and those in which they have next to nothing. We can call to mind a case in which a large mill engine fitted with expansion gear controlled by the governor, ran for a considerable period with the governor out of gear, some detail having broken. During that time the engine was controlled by the attendant, and the coal bill was rather less than usual. It must not be forgotten, too, that governors of the fly-wheel type are usually very heavy, and therefore tend to sluggishness. Even when a governor is used to control by expansion, everything depends on the engine as to whether the work of governing will be done as economically or satisfactorily in that way as by a throttle valve.

Much of Captain Sankey's reasoning is based on theoretical diagrams. We confess we look on these things with extreme doubt. They may be right. The chances are that no real engine performance is in accord with them. These diagrams are based on certain special experiments and deductions drawn by the late Mr. Willans. Thus, for example, Captain Sankey takes it as proved that with an initial pressure of 150 lb., the most economical average pressure in a compound engine will be 30 lb., and this will correspond with a consumption of 14·7 lb. of water per horse per hour. Now so far is the assumption from being true as a general proposition that dozens of cases might be brought forward to prove that there is no direct or natural connection whatever between 150 lb., 30 lb., and 14·7 lb. Thus, for example, on another page will be found reports of trials with two compound condensing engines, in which the boiler pressure is only 90 lb., and the consumption per horse per hour is much less than 14·7 lb. of water per horse per hour, although 150 lb. pressure ought to be more economical than 90 lb. One of the most important questions that the engineer of an electric light station has to solve is how to proportion his engine to give on the whole the greatest economy, the load varying through wide limits. To solve this Captain Sankey addressed himself; but we do not think that he has attached sufficient importance to the time element. Thus, in the not impossible case of an engine developing 300 to 600-horse power, it is certain that the latter load would not be on for more than, say, half an hour, while the former would perhaps be on for double that time; during most of its working life the engine would probably be exerting 450-horse power, and for that it should be proportioned. It is quite impossible, however, to predicate with any certainty what the steam consumption per horse per hour would be at either 300, 450, or 600-horse power in any engine, save in a very roughly approximate fashion. Of course Captain Sankey, having a wide experience of Mr. Willans' engines, can speak with certainty of them, but his diagrams cannot be held to apply to any other make of engine without qualification.

On the whole the paper is a very carefully reasoned statement of special deductions drawn mainly from the work of the late Mr. Willans, to which is superadded much that is obviously the result of a process of quiet cogitation on various aspects of a somewhat complex problem. It must be borne in mind that what he has said refers mainly to engines running at over 150 revolutions per minute. He points out that below that speed trip gear can be used, which is as simple as the throttle valve. This will not be universally accepted as correct, nor the further proposition that "up to 150 revolutions per minute throttle valve governing need not be considered." Indeed, it is in a measure a contradiction of his own statement that with non-condensing engines, such as may be found in every electric light station, throttle governing is more economical than expansion governing, irrespective of speed. He goes on to say:—"Above these speeds, however, variable expansion gears, being no longer of the trip class, require considerable power to work them as a rule, and it is usual to employ powerful shaft governors for the purpose. Such governors are clearly more expensive than throttle-valve governors, and are probably also less sensitive. The comparative simplicity of throttle-valve governors, and their greater sensitiveness under such circumstances, are in fact their great recommendation." We believe that very many of our readers will endorse these statements. All things, indeed, considered, we hold that engines running at speeds above 150 revolutions per minute will give better results with a proper throttle valve—the ratio of expansion being variable by hand, to enable the engine to adapt itself to large variations in load—than can be obtained by any form of fly-wheel governor that has yet been devised. Indeed, there are to governors of that class a multitude of objections, in the endeavour to overcome which hundreds of patents have been taken out—without, it would appear, much result up to the present.

LONDON AND FOREIGN FIRE BRIGADES.

THE annual report just presented by the Chief Officer of the Metropolitan Fire Brigade seems to invite some comparison between the London system of protection against fire, and that adopted in certain of the leading Continental cities. For this purpose we find sundry useful particulars in the "Notes" which have been published by a representative body of British firemen who visited Vienna on an official invitation last summer, and who extended their route so as to include Berlin, Venice, and several other places of importance. In the report by Capt. Simonds there is a record of 3061 fires occurring in London during the past year. This is a decrease compared with the two previous years, but is more than 500 above the average of the previous decenniad, and exceeds twice the number of fires which occurred in 1866. But the efficiency of the Brigade is shown by the reduction in the proportion of fires that are serious. These were 6·5 per cent on the average from 1884 to 1893, falling to 4·9 per cent. in 1894. Concerning human life, the number of persons who were seriously endangered by fire last year was 204. Of these 122 were saved, and 82 lost their lives—the same number as in 1893. In addition to the cases of imminent danger, 116 persons are known to have been exposed to lesser degrees of peril. Among the deaths thirty-two were caused by mineral oil lamps exploding or being upset. Taking the population of London as estimated by the Registrar-General for the middle of 1894, the fires were one for each 1420 of the population. In 1884, when the estimated population was 3,940,000, the fires were 2289, or at the rate of one fire per 1721 persons. In proportion to the population, therefore, the fires in London were fewer ten years ago than in the year just past. If we go back to 1874 we find that the fires were in the proportion of one to 2178 of the population. These figures are remarkable, and show either that the record is better kept now than formerly, or that London is becoming more combustible. One satisfactory feature consists in the fact that serious fires, which were 10 per cent. of the total in 1874, dropped to 9 per cent. in 1884, and last year were rather less than 5 per cent. The actual number of serious fires last year was a trifle less than in 1874, and more than forty below the number in 1884.

In Amsterdam there are 200 firemen to protect a population of nearly 450,000, the ratio being one fireman to 2250 inhabitants. In London we have four times as many firemen to protect a population more than nine times as numerous, the ratio being one fireman to 5500 persons. In Amsterdam the Brigade can be summoned from 250 fire-call points, so carefully distributed over the town that no house is further than 300 yards from a post. The annual average of fires in Amsterdam is said to be about 1500, exclusive of chimney fires. This is a high figure, being at the rate of one fire to each 300 of the population, or more than four times the London ratio of last year. We should almost think the fire statistics of Amsterdam were incorrect. In Berlin the Royal Police Fire Brigade is about 800 strong, and has to protect a population of 1,600,000. The Registrar-General gives it as 1,715,000. Adopting the latter figure, the firemen are one to 2144. The numerical strength of the force is the same as in London, but the metropolitan population is more than two and a-half times that of Berlin. In making these comparisons, we have to bear in mind that the London Brigade is solely devoted to the protection of the metropolis from fire, whereas on the Continent the duties may be sometimes of a mixed character. This does not seem to be the case in Amsterdam, where the Brigade is a municipal institution. Although at Berlin the police element is utilised, the Brigade appears to be a very distinct division. The men are recruited from various trades, principally, however, from bricklayers and carpenters who have completed their term of compulsory service in the army or navy. In the latter instance they bear some resemblance to the London Brigade, which has been largely composed of sailors, though it is possible that the seafaring members are less numerous than they were when Sir Eyre Shaw was at the head of the force. The County Council has other views than those which prevailed in the days of the Metropolitan Board. Battersea is now deemed as good a training ground as the deck of a sailing ship for men who are to be admitted into the Fire Brigade.

Vienna has lately enlarged her area by the addition of numerous suburbs. Prior to this change, the Brigade was 375 strong. There were 300 call-points in the city, of which about 200 were public street alarms. The men were recruited from all trades, but the officers were gathered in from the army and the architectural and engineering professions. The towns on the Continent visited by the British contingent of firemen were all found to be supplied with elaborate systems of telegraphic communication, some of which are described as almost perfection. Expense did not seem to have been spared, and the result generally is said to have been highly satisfactory. On the Continent, as in England, one great difficulty the Fire Brigades have to contend with consists in the malicious use of street alarms. To check this abuse, at Vienna the alarm cases have cast-iron hinged doors, which are kept locked, the keys being in the possession of respectable citizens, who are made responsible for the right use of the apparatus. We might almost suggest that the remedy is worse than the disease. Waking up a sleepy citizen at night in order to get the key of the alarm, appears a very slow process when a fire is raging. It is remarked that most of the firemen at Vienna are efficient telegraphists. Every man is taught telegraphy, and has to become expert in the use of the apparatus before he is considered a competent fireman.

A curious regulation exists in Buda-Pesth. The chimney sweeps are licensed, each one having a district allotted to him. "Woe betide him," we are told, if a chimney catches fire within a short period after he has swept it. In Florence, cycles fitted with hand-pumps and first-aid appliances are largely used, and are usually sent to small fires in advance of the engines. In Milan both bicycles and tricycles are extensively used as first-aid. Lucerne, with a population of only 22,000, has 400 firemen, or one for every 55 inhabitants. Up to the age of 44 years, every male is liable to serve in the Brigade. The careful use of water at Continental fires is a matter of remark, and the plan is approved by which a trumpet, bell, or fog-horn is employed to give notice that a fire engine is approaching, so as to clear the road in due time. In London, and in many towns in the country, it is observed that "we yet have the unsatisfactory shout." Yet it is marvellous how quickly the road is cleared for a London fire engine. Last Christmas time, when the route was packed with vehicles so that it seemed almost impossible for them to move, a fire engine came with a rush down Ludgate-hill, tore across the Circus, and dashed along Fleet-street without collision of any kind. Vienna could not have done better. Perhaps there is a risk about it, and a safer plan might be commendable. In Venice it is the practice for miniature manual fire engines, after the French pattern, to be conveyed to the scene of the fire on board gondolas which are kept in readiness for the purpose near the various fire stations. In London there are nine steam fire engines on barges, four floating or river stations, and eight steam tugs. Such are our gondolas.

Venice is remarkable for the entire absence of fire escapes of any kind. Still more extraordinary is the fact that the want of these appliances has never been felt, as there has been no loss of life from fire in that city for twenty-five years. It would be interesting to know how such immunity is secured. We must assume that it is due to the internal construction of the buildings, or to some ready means of extinguishing a fire in its earliest stage. At Amsterdam the ordinary canvas shoot is used, but it is always twisted a few times before anyone is allowed to enter it. The sheet is then gradually untwisted, according to the speed at which the descent is to be made. The English firemen were much struck at Amsterdam with one form of life-saving apparatus, which is worked on the same principle as the rocket and line used on the British coast in the case of a shipwreck. If a person is in a precarious or elevated position which cannot be reached by ladders or escapes, a fine hemp line is shot up to the individual endangered by means of a pistol. The person so aided is expected to draw the line up, and afterwards to haul in a stout rope, which has Turk's-head knots worked in it to facilitate climbing. A fireman is then generally sent up, and uses his life-line or shoot to bring down the person in peril. Jumping sheets are also employed at Amsterdam and elsewhere. At Berlin, fire suits or water jackets are adopted for the protection of the firemen. These contrivances consist of a blouse and trousers made of a double layer of canvas, and furnished with a diver's helmet. There are such arrangements in regard to the laying-on of the water supply, that on entering a burning building in his fire suit the Brigade man is able to fill the space between the inner and outer layers of canvas with water to whatever extent he may wish. If the space between the two layers of canvas becomes over-filled, the water escapes through a valve at the top of the helmet, and flows down over the fireman like a cascade, protecting him doubly. Smoke helmets are also employed. The paraphernalia of a Fire Brigade is thus far more elaborate on the Continent than it is with us. But we have fire escapes to a considerable extent. In London there are 200 fire escape stations and 225 fire escapes. These appliances are serving a double purpose. Since the practice was abandoned of giving half-a-crown to the first messenger who announced a fire at a Brigade station, the man in the street has not cared to run himself off his legs by racing with the news of a fire to the nearest station of the Brigade, where he will get nothing for his pains. But he goes to the fire escape station, and helps to move the fire escape, for which service he obtains remuneration. So far there is better protection for life than for property. Another feature of interest consists in the fact that the London fire engines have the command of thirty-five miles of hose.

A useful summary of the conclusions arrived at by the English party is given by Mr. Sachs and two other members of the contingent. They say there is much to learn abroad, though it is fully admitted that some of the appliances or methods which appear so admirable do not lend themselves to introduction in our country exactly as they stand. Speaking of life-saving appliances, the advantages of the hook ladder are much appreciated, and its immediate introduction here is recommended. As to smoke helmets, it is said there is every reason why we should have them in this country, but they must be used with great care. The fire suit, as shown at Berlin, is considered rather too complicated for most Brigades, though it might be found very serviceable in fires at warehouses. As for fire stations, there was little to be learned on the Continent, the latest stations of the Metropolitan Fire Brigade being "unequalled." Leather helmets are preferred to those of metal. In the case of theatres it is remarked that the safety of the audience is apparently the first consideration abroad. On the whole we have a very useful report from the party of eleven who went on the Continent last summer, to see how foreign cities were provided with means of protection for life and property against the ravages of fire.

THE UTILISATION OF THE NILE.

THE Secretary of the Society for the Preservation of the Monuments of Ancient Egypt has favoured us with a memorandum, which will be found in another column, on the draft scheme for the archæological survey of the Nile Valley between the First and Second Cataracts. The memorandum summarises the action of the Society under the compromise as to the level of the dam at Assouan assented to by the Egyptian Government, and the sanction given to a topographical and archæological survey of that part of the valley likely to be affected by the projected reservoir, and we can understand from the array of learned societies who are therein stated to have interested themselves in the Philæ question, how the gentlemen at the head of the Egyptian Public Works have been obliged to take up the position they have taken in preparing the revised scheme for the reservoir. At the same time we should not be surprised that the formidable extent and details of the operations contemplated under the sanction to the survey should cause dismay to the financial officers of the Government. We are pleased to note that R.L. 118 00 has been selected as the contour up to which the archæological examination and survey is to be carried. This is perhaps an indication of a not improbable expectation that the project will be restored to its original scope at some future period, and in the interests of this country, we hope that such may be the case. Notice has already been taken by us of the possibility of controlling and improving the supply of the Nile by works at the mouths of the great equatorial lakes. The Egyptian engineers are fully alive to this potentiality, for Mr. Wilcocks, in his monograph on the Nile appended to his report, states that "both the Victoria and Albert lakes lend themselves to be utilised as reservoirs, as they have rocky sills at their outlets, while the Albert and Tsana lakes, by their convenient size, are eminently suited for regulating basins." As a step in some scheme of this character our Foreign-office has been asked to erect a gauge on Lake Victoria in order to obtain readings which may be compared with the registers of the discharge at Assouan. It will be a truly magnificent achievement, and a crowning monument of our occupation of the country, if by the construction of suitable works on the lakes a plentiful and scientifically regulated supply of water can be ensured to the Nile valley during the summer months; thus the great lakes will become in their perfection what, in a degree, the Alpine snows and the Italian lakes are to the plains of Lombardy. But the opportunity which the situation now affords must not be allowed to slip away, and no diplomatic myopy of the present should be permitted to saddle future generations with embarrassments not to be easily removed. A professional journal is scarcely in its right place in dealing with political possibilities; but in consideration of the close relation which the Government policy in Central Africa bears to our subject, we may be excused in calling attention to the warning note sounded by Sir Colin Scott-Moncrieff in his lecture on "The Nile," delivered on the 25th of last month at the Royal Institution. He tells us that in 1884, when an expedition up the Nile was being first considered, he was asked whether there was any possibility of the river being diverted in the Soudan by the Mahdi? At that time he was sure there was no danger of such a thing: but what the hordes of the Mahdi could not then do a more civilised people in the future might. Suppose such a nation occupied Khartoum, it could easily spread the waters of the Lower Nile over the Soudan, and thus hold Egypt in its grasp, or if it were in possession of the Upper Nile it could by the construction of dams and regulating sluices across the outlets of the great lakes control, or even cut off entirely, the seasonable supply from Egypt. In either case Egypt would be at the mercy of any more powerful nation than herself, and could not exist except on sufferance under such conditions. We know that just now two such nations—friendly at present, it is true, both to Egypt and England—are closing in on the Soudan, so that unless, following up the lines of Mr. Rhodes' policy, English influence falls in as a wedge between, we may by a masterly inactivity lose our opportunity of preserving the situation, and Egypt may one day not long hence find cause to regret any relaxation of her claims to the Soudan, or England of her duties and opportunities between Tanganika and the confines of Egypt.

LOW PRICES IN SHIPBUILDING.

NEVER before, since shipbuilding began, have steamers been contracted for at such low figures as have been accepted recently by keen-cutting shipbuilders. For example, in the head-centre of the industry, the Clyde, there is at present being laid down the duplicate of a large cargo vessel built last year by the same firm, the saving on which is some £2000. Higher sums than this are also understood to have been "saved" in several cases. Builders, generally, are complaining of the difficulty they are experiencing in stemming the persistent efforts of owners still further to beat down the prices of new tonnage. At the least show of stiffening on the builders' part prospective owners cry off; but rather than have their berths unoccupied, and their expensive plant inoperative, many builders by hook or crook contrive to "stretch a point." This takes the form usually of squeezing their merchants and manufacturers, who, in their turn, with the large productive capacities of their works as an incentive, compete keenly for what is in the market. The result is a constantly descending scale of prices, and the notable fact that quite recently they have taken the lowest price ever recorded for steel ship plates and angles, £5 per ton for the former, and £4 10s. for the latter, less 5 per cent. Just at present steel makers are quoting 2s. or 3s. more a ton, but builders fight shy of buying at the advance. Doubtless the giving out of the Government orders shortly, under the recently declared Naval Programme, will have the effect of stiffening up makers' prices somewhat, forcing builders, who actually require material, to close at once. The influx of shipbuilding work for the Government will probably have the effect of bringing about the cessation of the flow of orders for mercantile shipping. Indeed, this has to a large extent already happened, and is not to be wondered at, considering that boats have been ordered in many cases, not because trade requirements on the condition of freights have warranted their construction, but because the terms have been such that ownership formed a tempting investment for capital.

GLASGOW WEIR.

A FURTHER development has taken place in connection with the tenders for the proposed weir or tidal dam across the river Clyde at Glasgow Green. In our issue of 2nd inst. it was stated that the committee charged with the matter had agreed to recommend that the offer of Messrs. P. M'Kissock and Son, amounting to £21,725 for the foundations and piers, should be accepted. This firm has now, however, withdrawn its tender, owing, it is understood, to the discovery of an error in making up the estimate, and at a meeting of the Town Council of Glasgow, held on the 7th instant, it was reported that the committee recommended that the second lowest tender, viz., that of Messrs. John Paterson and Son, be accepted. The amount of the tender was stated, after examination by a measurer, to be £26,104 0s. 6d., and provides for the upper portions of the piers being constructed of freestone instead of granite. The withdrawal of the lowest tender gave rise to considerable discussion, and a committee was appointed, including the Lord Provost amongst its members, to inquire into the matter. A full account of the weirs of Glasgow and their removal appeared in THE ENGINEER of September 21st, 1894, accompanied by illustrations.

IMPORTANT ALTERATIONS IN THE CARRIAGE OF COAL BY RAIL.

COAL merchants and large consumers of fuel are just now taking considerable interest in the action of the Midland, Lancashire and Yorkshire, Manchester, Sheffield, and Lincolnshire, and other leading railway companies. In respect to the carriage of coal and coke, the companies named have given one month's notice each of an important alteration which is to take effect on the first day of March next. From the period named only four days will be allowed merchants and consumers to unload wagons filled with coal or coke, and after that time siding or standage rent at the rate of 6d. per day will be charged so long as the wagon remains unloaded. Considerable latitude has been allowed, and although charges have been occasionally made for rent in respect of overdue wagons, the companies have been very forbearing. During the last two years the Midland Railway Company has been allowing a monthly average which, on the whole, is said to have worked satisfactorily. Notice has however, been given to withdraw the arrangement, and the company has agreed to throw in its lot with other companies. It is not expected that much assistance will be given by coalowners who are deeply interested in the speedy return of wagons. It is surprising the loss which is sustained by coalowners from this neglect. Many times during the year large collieries are obliged to "lock in" for want of wagons, so that it is expected that the notices will be allowed to take their course. In some parts of the West Riding meetings have been held to protest against this change, but it is not expected that their efforts will prove successful in getting the notices withdrawn.

LIGHT RAILWAYS.

AT a full but not overflowing meeting at the Society of Arts, on Wednesday evening, Mr. Acworth proceeded further to educate the public in official opinion as to light railways. He neatly shelved the financial question by saying that when an Act relaxing many of the present restrictions had come into operation, and it was seen how far private investors would go—or not go—it would be time enough to consider State aid. This, however, is one bid higher than Mr. Bryce went at the meeting of December 6th last. Mr. Acworth dealt mainly with the subject of the legal restrictions on the making and working of railways, and contrasted our regulations with those of other European countries. He might have further emphasised this theme by quoting the American practice, where the main railways run through principal streets of large cities without let or hindrance, and the only care taken of a level crossing in the country is to put up a notice that this is one, and that you are to "look out for the cars." We quite go with him in the opinion that unless restrictions are removed to a great extent there will be no light railways. Whether there will be any when they are removed is another question. The cases of lines made without sanction in the North are all for private mineral traffic, and were doubtless in the interest of the local landowners. It is not necessary to go back to the native country of railways for instances of this kind. The often-quoted Festiniog line was so made in the first instance, though it afterwards obtained legal powers and a Board of Trade certificate; and we know of at least one other mineral line of eight or nine miles laid over fifty years ago, generally beside the road, by consent of grand jury and landed proprietors. But such arrangements are now all but impossible. By all means, let us have a relief of disabilities Bill and see what will come of it, but we do not seem to get on with other business so as to give any immediate promise of this.

LITERATURE.

Electrical Engineering as a Profession: How to Enter it, and Guide to the Engineering Profession. Official Edition. By A. D. SOUTHAM. Price 3s. 6d. London: Southam and Co. 1895.

CONSIDERING the difficulty which attends any attempt to advise generally on this subject, the book before us is a satisfactory treatment of the question. The first part gives information which will help those who have to decide upon a course for a youth. As the prevailing tone is a higher appreciation of the system of learning by apprenticeship in works after a good elementary education, and concurrently getting as much technical education as a youth can obtain in technical colleges in the evening, and by his own studies directed by a common-sense view of what he finds in the daytime to be his chief requirements, the book is to be commended. There are some apparently conflicting statements and opinions with regard to the requirements of an engineer and of an engineering education, but most of them are only conflicting because of the necessity for looking at the matter from the different points of view of those who have written upon the subject. It is, therefore, necessary that a parent or guardian thinking of electrical or other branches of engineering for a youth should read the whole of the various opinions expressed, and particularly those which show how utterly useless it is, and more than useless, to put a youth to electrical engineering unless he has, firstly, a strong liking—not a mere model-making liking—for it; secondly, the ability to work long hours, and to teach himself from what he sees and from what he should be able to see he does not know; thirdly, he should be sufficiently interested in the work, and impressed with the necessity for sticking to it, to go on when the task is discouraging or not interesting. Further, it is useless to put a youth to any branch of engineering who from any reason, whether want of energy or common sense, is unable to use a good deal of his evening time in the study of the theory and application of it to the questions which arise in connection with his work of the day.

The author says it is not true that the electrical engineering profession is overcrowded, "for there is always room for a good man and one who knows his business." This is, however, no proof that the profession is not overcrowded, chiefly by those who have been through too long a technical day college training, to the loss of the practical training during the early life when workshop—not laboratory workshop—knowledge is quickly learned. The author is a little lax in his notions as as to the position of a consulting engineer, for he says "an engineer may be either consulting, contracting, or manufacturing; the two former and the two latter often running together. For obvious reasons a manufacturer cannot always be a consulting engineer." The notion that either a contractor or contracting engineer can with propriety be a consulting engineer cannot be too strongly condemned. There is a great deal too much laxity on this subject, especially in electrical engineering. The second part of Mr. Southam's book is a description of the principal technical institutions, and the third part deals with apprenticeship with a firm, and gives particulars of electrical and general engineering firms, with the opinions of the heads of some of these, and attention may be directed to those given by Mr. Paxman. Reference may also be made to the opinions of Mr. E. E. Brown, Professor Kennedy, and of Mr. W. B. Esson, on pages 23 and 24.

Catalogue of the Exhibit of the Pennsylvania Railroad Company in the World's Columbian Exhibition. 1894.

WE have received a beautifully got-up work with the above title, which is very fully illustrated, and creditable to the railway company. Our readers will remember that we described in page 397 of our issue of 27th October, 1893, some of the features of this exhibit, and in page 402 of the same number published a full-page illustration of the special building in which the smaller exhibits were housed, and the length of track laid down to carry the John Bull engine and train, as well as the large trucks specially designed for the transport of heavy ordnance. The building contained a most interesting historical collection, the purpose of which was not only to perpetuate the early history of the Pennsylvania Railroad Company, and of the lines merged into or associated in interest with it, but also to place on record the gradual improvement in the means of transportation. The whole of the collection described in the catalogue was sent to the Field-Columbian Museum of Chicago by the Pennsylvania Railroad Company immediately after the close of the Exhibition, and is now installed in Halls 41 and 57 in the East Pavilion of the Museum Building at Jackson Park, Chicago.

While in the United States, our special commissioner received every assistance from Mr. Theo. N. Ely, the chief of motive power at Philadelphia, and also from Mr. J. Elfreth Watkins, the special agent in charge of the exhibit; the names of both these gentlemen appear on the title page of this volume. One can scarcely imagine a British railway company going to the expense of first exhibiting upon such a scale at an exhibition, then presenting the whole of the exhibit to the city where the exhibition was held, and lastly, publishing such a catalogue as is now before us. Probably the shareholders in this country would complain, but the truth is that competition between the railway companies is so keen in the United States, and especially so upon the lines running into Chicago, that it is essential to take means to cause the public to realise the importance of such a vast network of lines as that comprehended under the official title of this company. Some interesting old posters, way bills, and tickets are reproduced at the end of the book; the earliest date from 1835, when the passengers were carried from Philadelphia to Pittsburg, 394 miles, in 4½ days, by the Pennsylvania canals and railroads, and this should be contrasted with the statistical models, which must have been particularly striking to the general public, for they show that last year the company owned 14,278 miles of track, and if the rails were welded together continuously, they would reach round the globe, and overlap from New York to a point in the Pacific Ocean within 1400 miles of Honolulu, Hawaii.

The locomotive mileage upon the system is 107,000,000 miles per year, so that one locomotive may be said to travel round the globe every two hours. The capital invested is 675,000,000 dols., which was illustrated by stating that it would need two rows of silver dollars laid with their edges touching along the entire length of the 7980 miles of railroad comprised in the system to make up the sum. The freight and passenger movement is equal to one ton hauled round the world—25,000 miles—in 63 seconds, and one passenger conveyed round the globe in 7¾ minutes. The coal consumed is ten tons per minute; the petroleum used amounts to 375 barrels per day; the persons employed in 1892 numbered 104,021; the amount paid during that year in wages was 57,520,340 dols. It is clear, therefore, that the enterprise is colossal.

Many beautiful models of the various systems of transport were shown at Chicago, and are illustrated in this catalogue from the old coaches and canal boats of 1835, to the finished and elaborately decorated Pullman cars of the present day. Fac-similes of old invoices and bills of lading are given; one of the latter, dated July 14th, 1831, is for the first rail laid in the world rolled with a horizontal flanged base. This rail was invented by Robert L. Stevens, shipped from Liverpool by Francis B. Ogden in the ship Montezuma, bound for Philadelphia, and laid near Bordentown, New Jersey, where the railroad monument now stands to commemorate the first movement by steam between the cities of New York and Philadelphia by the locomotive John Bull. A charge of £784 7s., the price paid Messrs. Robert Stephenson and Co., of Newcastle-on-Tyne, for the locomotive John Bull, shipped in the Allegheny to Philadelphia, is made under date of June 27th, 1831, and the original bill of lading showed that it was shipped on 14th July, 1831. The work contains several examples of old rack rail locomotives, and is a valuable record of a very interesting collection obtained through the co-operation of scores of donor whose names are given.

The Progress of Science; its Origin, Course, Promoters, and Results. By J. VILLIN MARMERY, with an Introduction by SAMUEL LAING. London: Chapman, Hall, and Co. 1895. Price 7s. 6d.

THIS is a very unsatisfactory book. Concerning a great portion of the subjects referred to there is a very evident want of knowledge and of grasp. Incompleteness in the work as a reference book is everywhere found, and generalities only permissible in after-dinner talk prevail. The work of preparing the book may have given the author some pleasure; but he has apparently been so impressed with the necessity for brevity that he has robbed it of precise facts and dates rather than of off-hand statement. It is news, for instance, that Faure invented the electric accumulator, which is described by two lines, which are as follow:—"A new and fruitful apparatus for storing power which makes the electric train or car an inexpensive possibility." The explanations of the work of Marriotte and Boyle, and many others, is almost as unsatisfactory, and indeed useless. Perhaps it would have been better if the author had confined his attention to a few of the questions which he airily describes as soon to be solved, such as "the tidal power of the sea will be pressed into service," "the time is not far distant when sunlight and heat will be stored directly and turned into mechanical energy," and "modern science has brought the solution of every physical problem within the compass of possibility." The book is on nice paper, but it is a pity it could not supply something that is not already as well or better given n several cyclopædias.

BOOKS RECEIVED.

The Windsor Magazine. Vol. i., No. 2. February, 1895. 6d. London: Ward, Lock, and Bowden, Limited.

Plating and Boilermaking: A Practical Handbook for Workshop Operations. Including an Appendix of Tables by A Foreman Pattern Maker. With 338 Illustrations. London: Crosby Lockwood and Son. 1895.

Mechanics: An Elementary Text-book, Theoretical and Practical, for Colleges and Schools; Dynamics. By R. T. Glazebrook, M.A., F.R.S. Price 4s. Cambridge: At the University Press. London: C. J. Clay and Sons. 1895.

The Shipbuilding and Marine Work of the Whole World, and Review of Leading Trades in Scotland, &c., for 1894, with Trade Prospects for 1895. Price 1s. London: Effingham, Wilson and Co. Glasgow: Proprietors of *The Glasgow Herald.*

The Engineers' Year Book of Formulæ, Rules, Tables, Data, and Memoranda in Civil, Mechanical, Electrical, Marine, and Mine Engineering. By H. R. Kempe, A.M. Inst. C.E., M.I.E.E. With 750 illustrations specially engraved for the work. Second year of publication. Price 8s. London: Crosby Lockwood and Son. 1895.

Brewery Companies. A reprint from *The Statist* of a series of articles appearing from August 25th to December 15th, 1894, furnishing for the first time full particulars and authentic data concerning all Brewery Companies registered up to November 30th, 1894. Revised and corrected to date, by H. S. Price 2s. 6d. London: *The Statist* Office. 1895.

Journal of the Association of Engineering Societies. Vol. xiii. December, 1894. No. 12. Published monthly by the Board of Managers of the Association of Engineering Societies. Price 30 cents per number. Philadelphia: John C. Trautwines, jun., Secretary, 419, Locust street.—This is principally an index to current engineering literature for the past year. There are besides two papers with discussions; one on transition curves, and the other on tests of cement joints for pipes.

The Universal Electrical Directory (J. A. Berly's), containing a Complete Record of all the Industries Directly or Indirectly Connected with Electricity and Magnetism, and the Names and Addresses of Manufacturers in Great Britain, India, the Colonies, America, the Continent, &c. Price 4s. London: H. Alabaster, Gatehouse, and Co. 1895.—This directory has been published for many years, and enjoys an excellent reputation. A little more care in revision would be desirable, however, as we find certain names given of individuals who are either dead or have changed their addresses. These blunders, however, are few, and possibly unavoidable.

Dynamo Construction: A Practical Handbook for the Use of Engineers, Constructors, and Electricians-in-Charge. By John W. Urquhart, electrician, with numerous illustrations. Second edition, revised and enlarged. London: Crosby Lockwood and Son. 1895.—This is the second edition of a very well-known book. It has been made larger than its predecessor by a chapter on the multiphase dynamo. There are no mathematics that are not readily intelligible to anyone who can read a simple algebraic formula, and all or nearly all the illustrations are new, having been specially prepared for the book. It is a very complete and satisfactory work as far as it goes.

Water Softening and Scientific Filtration. By Walter George Atkins. Price 1s. London: E. and F. N. Spon, 1894. The importance of the removal of the carbonate of lime and of magnesia and other impurities from the water used in steam boilers will impart to this book a value which will be the greater because it is not easy at present to find the necessary information on the subject, more especially in connection with the necessary machinery for carrying out the process. Mr. Atkins is interested, as is well known, in one of the systems of softening plant, which have been largely adopted in different parts of the country; but his book, nevertheless, treats the subject from the independent point of view, and it will be found of considerable value to not only steam boiler owners, but to laundry and manufactory owners.

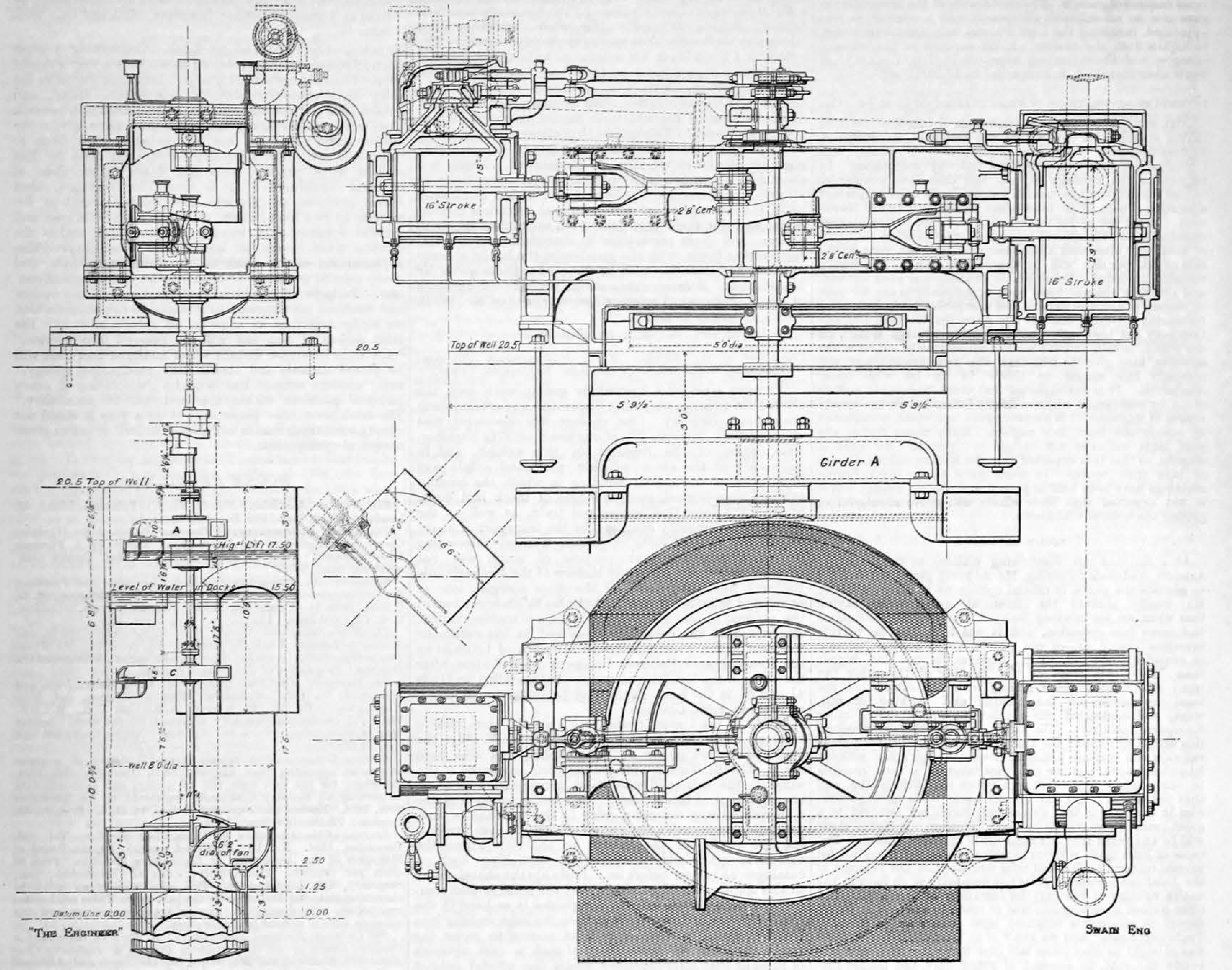
Stresses and Thrusts: A Text-book for Students. By G. A. T. Middleton. Illustrated with 114 diagrams. Price 5s. London: B. T. Batsford. 1895.—This is a revised edition of a little book which explains, first, the principles involved in graphic estimations of stresses as based upon parallelogram, triangle, and polygon of forces. The student is easily led to an understanding of the nature and direction of the forces to be met by the chief parts in girders and beams, and then after a brief explanation concerning vertical shearing stresses the analytical method is followed. The two systems of arriving at stresses and girders are thus explained together, and the graphic method is dealt with in the latter part of the book with great clearness, and which makes it useful to architects, and engineers, and students. The book concludes with chapters upon walls and chimneys to resist wind pressure only, and on retaining walls subject to earth and water pressure. Abutments and arches and the forces they have to resist are also briefly treated.

ARTHUR JACOB.

ON the 7th inst. passed away at Clapham an engineer who in a very unobtrusive way did a great deal of excellent work. Arthur Jacob was born near Dublin on the 4th of July, 1831. He was the son of Dr. Jacob, whose profound attainments as an oculist have made his name celebrated. "Jacob's

ENGINES AND CENTRIFUGAL PUMPS, VICTORIA DOCKS

MESSRS. EASTON, ANDERSON, AND GOOLDEN, LONDON, ENGINEERS



Rods" in the retina are known to all physiologists. Arthur Jacob graduated at Trinity College, Dublin, in 1855, took the degree of Bachelor of Arts, and obtained the diploma in civil engineering in 1856. At the end of the same year he went out to India, and took service in the Public Works Department of Bombay in 1857 as assistant to Captain—now General Sir—M. K. Kennedy, R.E., then Executive Engineer in the Satara District.

Mr. Jacob was at first employed on the construction of one of the large bridges on the Koombarli Ghaut Road, and afterwards, at the close of the Indian Mutiny, on the preparation of a project for the water supply of the town of Satara. Somewhat later he was deputed to survey and construct roads to open up the Belgaum districts. In the discharge of all these duties the young engineer gave ample satisfaction.

In 1859, when twenty-eight, he was summoned to Bombay to assist Colonel De Lisle in the survey for reclamation and defence work in the harbour. This done, he went back to Satara on irrigation survey work for the Kinhua project, and remained there till on a reduction of the Public Works Department caused by the restriction of the expenditure on public works, he lost his appointment in common with a large number of junior engineers; but Jacob was far too good a man to be left idle, and he at once obtained work under Mr. Ker on the G.I.P. Railway constructions at Kundwa, doing excellent service.

In 1862, when irrigation was started as an independent branch of the public works, Mr. Jacob was offered and accepted re-appointment to the Government service in Bombay, and was employed under Colonel Fife on irrigation works in the Satara district, where he remained till in 1864 he, for private reasons, resigned the service, returning to England. During the latter portion of his stay in India he assisted in preparing and partly carried into execution several projects, among which were the Reruri canals, the Krishna dam, and the Nhe reservoir. Shortly after his return to England he obtained employment on the Croydon Local Drainage Works under Mr. Baldwin Latham, and later on, in 1867, he competed for and obtained the appointment of borough engineer to the Bromley Local Board, and carried out the drainage works of that place. But Bromley did not afford sufficient scope for the talents of a man of his calibre, and the appointment of borough engineer to the town of Barrow-in-Furness being open to competition, he was selected, and entered on his duties there in 1872, and completed the extensive drainage works of that rapidly-growing seaport.

Mr. Jacob remained at Barrow until 1877, when he competed for the appointment of borough engineer to the Salford Corporation. Taking the place of Mr. Alfred Fowler, who resigned Salford on getting a similar appointment at Newcastle-on-Tyne, Mr. Jacob held his appointment at Salford until about four years ago, when he was compelled by failing health to retire from public life. During the period he was at Salford he carried out, in the most satisfactory manner, many important works, among which may be mentioned two iron bridges across the Irwell, a very extensive sewage scheme, and later on the laying out and development of farms for the utilisation of the Salford sewage, which involved some heavy drainage work, and a pumping apparatus on a very large scale. He took much interest in the Ship Canal, and it is worthy of note that the trace he prepared was very nearly that ultimately adopted. He was consulted on several drainage schemes, and was employed to report on various works, as well as to assist at some arbitrations. He was the author of several professional contributions and papers, one of which, on storage reservoirs, was read at the Society of Engineers, 1866. He became an Associate of the Institution of Civil Engineers in 1864, and was promoted to membership in 1875. Mr. Jacob leaves a widow and several daughters, but no son. Quiet and reserved, except among intimate friends—and they were numerous—less was heard of him during life than was his due. All his ways were those of a refined and courteous gentleman, and his death will be regretted by many who knew him either through business relations or as private friends.

PUMPS AT THE WEST INDIA DOCKS.

In our impression of the 24th August last we published an illustrated account of the new Blackwall entrance to the West India Docks. One of the diagram illustrations which we gave showed the positions of the engines and the large centrifugal pumps by which the docks are emptied. We now publish illustrations of the engines and pumps, which were constructed by Messrs. Easton, Anderson, and Goolden. There are four of these pumps, each capable of delivering 5000 cubic feet per minute, or 31,200 gallons per minute, or over 8000 tons per hour on a mean lift of 7ft. When all the pumps are in use, this gives the enormous dock-emptying capacity of 33,214 tons per hour. The speed of the pumps and engines on the maximum lift is 110 revolutions; the pump fans being 6ft. 2in. in diameter, and 20in. deep. The engine cranks are placed at 180 deg., so that the reciprocating masses are balanced. The engines have cylinders which are high-pressure 15in., low-pressure 29in., and stroke 16in. For a description of the positions and duties of these pumps and engines we refer the reader to the impression above mentioned, in which they were fully set forth.

THE MANCHESTER ASSOCIATION OF ENGINEERS.—The members of this Association held their thirty-ninth anniversary dinner on Saturday last, upwards of 150 being present. The chair was occupied by Sir E. Leader Williams, and among those present were Sir Joseph Lsgh. M.P., the Mayors of Salford and Bury, Sir W. H. Bailey, Sir Bosdin T. Leech, and Mr. C. H. Bingham, the Master Cutler of Sheffield.

INSTITUTION OF CIVIL ENGINEERS: ASSOCIATION OF BIRMINGHAM STUDENTS.—The tenth annual dinner of the Association was held on the 7th instant, at the Grand Hotel, Birmingham, Mr. Robert Godfrey, engineer and surveyor to the King's Norton District Council, president, in the chair. Among those present were the Mayor; Alderman Fallowes; Messrs. Charles Hawksley, Member of Council of the Institution of Civil Engineers; S. R. Lowcock, vice-president of the Association; J. E. Willcox, past president; and the engineers to many of the neighbouring towns.

FIRE AT AN ELECTRIC LIGHTING STATION.—We regret to inform our readers that a serious fire broke out on Wednesday night at the Kensington Court Supply Station of the Kensington and Knightsbridge Electric Lighting Company, resulting in the death of one of three children whose father, the foreman of the station, was unable to save it from suffocation. The fire is said to have originated in the office from some unexplained cause, the first effect being the extinction of all the station lights, the fuses in connection with which were situated close to the place of outbreak. The men in charge at the time stopped the two machines then running, the supply being maintained by the accumulators at the Queen's Gate and Knightsbridge Stations, especially by the former, which, we are told, practically maintained the supply. Considerable anxiety was felt concerning a tank of astaki liquid fuel situated above the boilers, which, although in close proximity to the fire, was not ignited, while the heat was sufficient to ignite coal in its immediate vicinity. The accumulators are absolutely ruined, and are now merely worth their weight in lead; the flooring on which they existed being fortunately fireproof on its upper surface—where attacked—remained sound. This fact saved the engines and dynamos below, as the volumes of water discharged by the hoses above the floor were unable to permeate it. The water, however, fell in a cataract at the edge of the flooring on to the switchboard connections, which were temporarily destroyed, chiefly by the large quantities of sulphuric acid which had been liberated by the collapse of the accumulator boxes. The switchboard is for the present, therefore, *hors de combat*, and temporary connections have been established from the machines to the mains, which are run on the three-wire system. In this way the supply has been absolutely uninterrupted under most adverse conditions—in the shape of smoke, acid, water, and ice, to say nothing of a full "fog" load. The boilers maintained their pressure throughout. This reflects great credit on the energy of Mr. Crompton and the staff in charge of the installation.

LOCOMOTIVES AND TRAINS.

MONS. DU BOSQUET, a well known French railway engineer, has done much in the way of investigating the resistance of railway trains, and we give an abstract from the transactions of the Institute of Civil Engineers, which gives certain results and conclusions at which he has arrived. Mr. Ivatt, the locomotive superintendent of the Great Southern and Western Railway of Ireland, holding that it would be well to put M. Du Bosquet's figures into a very readily understood form, has prepared a most instructive diagram, which we reproduce on a reduced scale. It will be understood that while the figures are M. Du Bosquet's, the diagram is Mr. Ivatt's.

The author has determined by the aid of the dynamometer the resistances per ton that the train opposes to movement on the level at different speeds. These resistances, obtained on the coupling of the tender, are only the resistances of the train, and they do not comprise the portion of the resistance of the air which is exerted in front of the engine, nor that of the engine itself. Upon the basis of these resistances the author has obtained those for up and down gradients of 1 in 200, and gives the following tables :—

Speed in miles per hour.	Resistance per train-ton in pounds.		
	On down-gradient of 1 in 200.	On the level.	On up-gradient of 1 in 200.
31	–4·48	6·72	17·92
37	–2·24	8·96	20·16
43	0·00	11·20	22·40
50	2·24	13·44	24·64
56	5·82	17·02	28·22
62	9·32	20·52	31·72
68	13·44	24·64	35·84
75	17·92	29·12	40·32
81	22·40	33·60	44·80
87	28·00	39·20	50·40
93	33·60	44·80	56·00
99	39·56	50·76	61·96
106	45·92	57·12	68·32
112	62·64	63·84	75·04
118	59·58	70·78	81·98
124	67·20	78·40	89·60

Horse-power Necessary to Move One Ton of a Train at Different Speeds on the Level and on Up and Down Gradients of 1 in 200.

Speed in miles per hour.	On down-gradient of 1 in 200.	On the level.	On up-gradient of 1 in 200.
31	negative	0·54	1·47
37	,,	0·87	1·96
43	nil	1·27	2·54
50	0·29	1·73	3·15
56	0·84	2·48	4·11
62	1·52	3·33	5·19
68	2·41	4·40	6·45
75	3·48	5·66	7·84
81	4·74	7·10	9·46
87	6·37	8·82	11·37
93	8·20	10·82	13·77
99	10·25	13·13	16·07
106	12·69	15·73	18·67
112	15·34	18·62	21·88
118	18·38	21·84	25·25
124	21·56	25·48	29·00

From these tables it will be seen that under the same resistance per ton of 17·92 lb. a train will travel at a speed of 75 miles on a down-gradient of 1 in 200, at 57 miles on the level, and at 31 miles on an up-gradient of 1 in 200; and that for the same horse-power of 3·33 per ton a train will travel at 74 miles an hour on a down-gradient of 1 in 200, 62 miles an hour on the level, and at 50 miles an hour on an up-gradient of 1 in 200. To run down a gradient of 1 in 200 with a train weighing 200 tons—exclusive of the engine—at 75 miles an hour a horse-power of 200 × 3·48 = 696 would be required, and the author also points out that to gain a few miles in speed per hour at the higher speeds a considerable increase of power is necessary. Taking a train weighing 100 tons—being the minimum weight of the through passenger trains—the power which it would be necessary for the engine to develope in order to ascend a gradient of 1 in 200 at the following speeds would be :—

	H.P.
At 50 miles	315
,, 62 ,, ...	519
,, 75 ,, ...	784
,, 93 ,, ...	1377
,,106 ,, ...	1867
,,124 ,, ...	2900

These results are obtained without taking any consideration of the power necessary to drive the engine itself.

The author then takes engines in the best possible condition as far as friction and resistance to the air are concerned, and applies to them the same coefficients of resistance as for the train. Four engines are taken, one weighing 220 lb., the second 165 lb., the third 110 lb., and the fourth 77 lb. per horse-power—the weight of the engine per horse-power being a very important feature. The first question considered is at what speed these engines are capable of moving themselves. Taking the relation of the horse-power to the ton :—

	H.P.
1 ton of the first engine can produce	10·00
1 ,, ,, second ,, ,, ,, ...	13·33
1 ,, ,, third ,, ,, ,, ...	20·00
1 ,, ,, fourth ,, ,, ,, ...	28·50

The power per ton necessary on an up-gradient of 1 in 200 at a speed of 124 miles an hour being 29-horse power—see table—none of these engines can attain this speed. The first would not exceed 82 miles, the second 92 miles, the third 108 miles, and the fourth 121 miles. A train weighing 100 tons is now attached to each of these engines, and the author proceeds to determine what the weight of the engine should be in order to draw this load at different speeds on an up-gradient of 1 in 200, and what horse-power the engine would have to develope. These are determined by the following equations: the weight of the train and the weight of the engine, multiplied by the horse-power absorbed by one ton at the speed under consideration, is equal to the total horse-power; and the total horse-power multiplied by the weight of the engine in pounds per horse-power is equal to the weight of the engine in pounds. By the aid of these formulas the following table is given :—

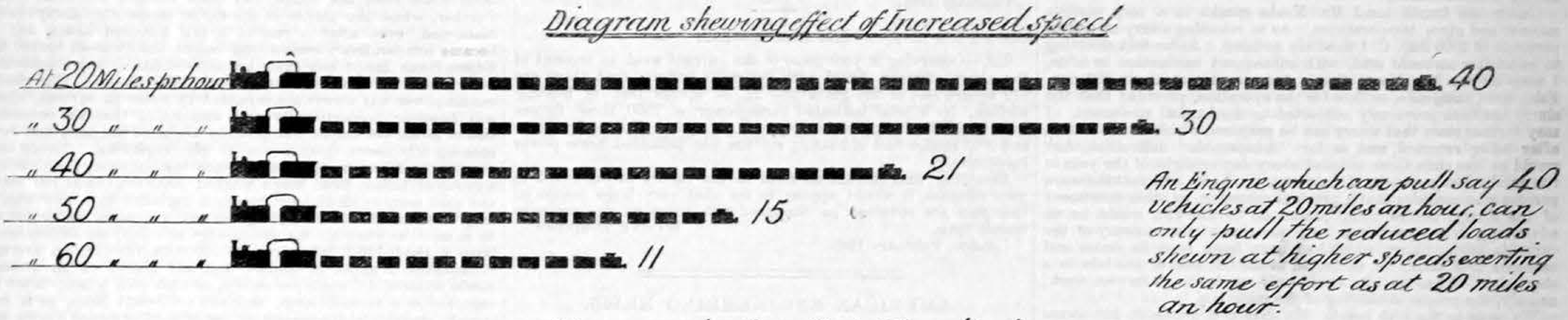
Weight of Train 98 Tons. Up-gradient of 1 in 200.

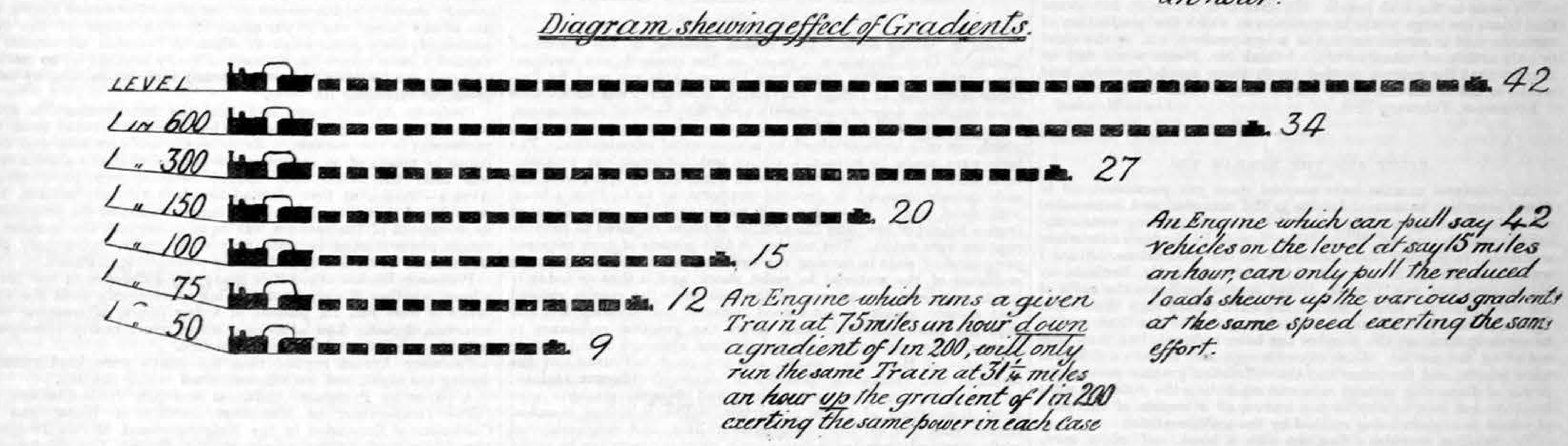
Speeds in miles per hour.	Engine weighing 220 lb. per H.P.			Engine weighing 165 lb. per H.P.			Engine weighing 110 lb. per H.P.			Engine weighing 77 lb. per H.P.		
	Weight of engine in tons.	Total weight in tons.	Total H.P.	Weight of engine in tons.	Total weight in tons.	Total H.P.	Weight of engine in tons.	Total weight in tons.	Total H.P.	Weight of engine in tons.	Total weight in tons.	Total H.P.
62	108	206	1,078	64	162	850	35	133	696	22	120	627
68	181	279	1,814	91	189	1,227	47	145	1,021	29	127	828
75	392	490	3,920	147	245	1,960	65	163	1,306	38	136	1,090
81	2,352	2,450	23,520	254	352	3,377	90	188	1,807	49	147	1,412
87	—	—	—	656	754	8,753	132	230	2,671	69	167	1 889
93	—	—	—	—	—	—	228	326	4,569	94	192	2,689
99	—	—	—	—	—	—	435	533	8,741	130	228	3,631
106	—	—	—	—	—	—	1,862	1,960	37,240	196	294	5,586
112	—	—	—	—	—	—	—	—	—	340	438	9,741
118												
124												

The Crampton engine, made in 1849, weighed 50 tons, and was capable of developing 400-horse power, thus weighing about 275 lb. per horse-power; the engines, which are constructed in France at the present day, weigh about 80 tons and develope up to 1100-horse power, that is, 158 lb. per horse-power.

Thus the tendency has been to reduce the weight per horse-power, and has met with considerable success; and henceforth a further saving in the weight will take place in reducing the dimensions of the tender and taking water whilst running, and thus reducing the weight per horse-power to 143 lb.

The author concludes by saying that if higher speeds are to be attained it is absolutely necessary that nothing be carried by the vehicles which is not indispensable, and that the question of reducing the resistance must be carefully studied.





SOCIETY FOR THE PRESERVATION OF THE MONUMENTS OF ANCIENT EGYPT.

SCHEME FOR SURVEY.

EARLY in June, 1894, the above-named Society discussed the importance of having a thorough survey made of the Nile Valley from the First to the Second Cataracts, that is to say, of the district which will be partially converted into a huge reservoir when the dam at Assouan, even in its reduced proportions, is constructed, and in the selection of the scheme for such a survey, the Society received the support and co-operation of the Royal Academy, the Royal Society, the Society of Antiquaries, the Dilettante Society, the Society for the Protection of Ancient Buildings, the Society for the Promotion of Hellenic Studies, the Royal Institution of British Architects, and the Egypt Exploration Fund. A representative committee was formed, and in July adopted a survey scheme which had been drawn up by a sub-committee, consisting of Sir Colin Scott Moncrieff, K.C.M.G., Professor Norman Lockyer, C.B., F.R.S., and Mr. Somers Clarke with Mr. Alan Cole as hon. sec. In the district which will be affected there are some forty places, at each of which are temples and other important architectural remains of high archæological interest, which will be partly submerged. Amongst these places are Philæ, Dabod, Kertassi, Kalabsha, Sebua, Ermenna, Fer Serreh, Wadi Halfa, and Matuka. There are also Graffiti hieroglyphics, Semitic and Greek, on isolated rocks or cliffs on either side of the river, which require careful examination and copying.

It is proposed that the survey should commence with a preliminary reconnaissance, providing a general map and maps of sites, to be followed by plans of the buildings and special inquiries. If the maps and plans cannot be prepared for publication in Egypt, it is thought that, under the special circumstances of the case, the Board of Agriculture in Egypt might consent to their multiplication by the Ordnance Survey, which would result in perfect reproduction and a great economy. Illustrations other than plans are to be based on photographs and subsequently processed in printer's ink, securing permanency and avoiding all expenses of hand illustration. It is further suggested that a non-commissioned officer of the Royal Engineers, who has passed through the photographic school at Chatham, should be attached to one of the companies of the Royal Engineers stationed in Egypt, and be employed in obtaining photographs.

As regards topography, the general survey of the region may possibly be based on the engineer's map, and plotted on a scale of 1-100,000th. All special sites should be specially surveyed on a scale of 1-10,000th, giving precedence to the districts and buildings likely to be submerged at the lower levels of the water as it rises in the reservoir region. These sites should include :—(1) Temple fields; (2) forts; (3) groups of rock tomb; (4) old towns and prehistoric sites; (5) mounds; and (6) old cemeteries and their circles, &c. The large underground cemeteries in the neighbourhood of the temples and great towns should be sought for and excavated. The magnetic variation should be astronomically determined at each site, and the true (astronomical) north shown on every map. Contours should be given, say, to a scale of three metres.

For the first stage of a preliminary reconnaissance it is suggested that (1) A contour line at river level, 118, should be shown in the general topographical map. (2) All sites likely to be occupied by cultivation or dwellings should be noted. (3) The feasibility of placing cofferdams or earthen embankments round buildings liable only to slight flooding should be considered. (4) The extent of cemeteries should be noted; and (5) Graffiti that will be flooded should be catalogued.

The second stage of this reconnaissance would deal with (1) Mapping in detail of sites, plans of temples, &c. (2) Photographing of all visible inscriptions. (3) Obtaining levelled height of each temple floor above the Nile water at some stated date so as to compare with Aswân and Halfa gauges. (4) Obtaining proper names in the Nuba dialect of every site. (5) Examining the plan and levels of all the ancient training spurs on the river banks. (6) Noting all evidence of the Nile having been at different levels in historic times. (7) Searching for all stages of Graffiti, &c., near the river level, and all that are dateable, with a record of what can be reached on foot or otherwise.

The scheme for the fuller survey goes on to indicate methods for carrying out subsequent local investigations, and it is understood that the preliminary reconnaissance is now about to commence under the direction of the Public Works, Irrigation, and Archæological Departments of the Egyptian Government in accordance with the foregoing scheme.

BRISTOL UNIVERSITY COLLEGE ENGINEERING SOCIETY. — A general meeting of the Society was held at the college last week, to hear an address by Senhor Honoria de A. Maia, one of the hon. vice-presidents of the Society, who for some years was a student at the college. Senhor Maia is now pursuing the study of practical engineering in the works of Messrs. Dobson and Barlow, of Bolton. Dr. Ryan, in a few prefatory remarks, said that although he was ill and ought to be in bed, he had come to hear the interesting and instructive paper of Senhor Maia. Dr. Ryan also remarked that it was very pleasant to see old students of the college returning to give an account of the experience they had acquired elsewhere. The subject of Senhor Maia's paper was "Textile Machinery." The lecturer first descanted in a most instructive manner on the several varieties of cotton, amongst which that grown in Brazil holds a very prominent position. Passing from the consideration of the raw material to the machinery by which it is turned out in its usual commercial form, the lecturer entered into an elaborate description of all classes of cotton "gins," and in detail described the machines used for separating the cotton seeds—from the primitive foot roller to the Dobson patent "gin." He then traced a bale of cotton from the ship until it was spun and woven, in this instance, in one of the most important cotton factories at Rio de Janeiro. Of the machinery employed in this establishment Senhor Maia gave a graphic description, explaining in detail each piece of mechanism used till the process of manufacture was completed.

LETTERS TO THE EDITOR.

(*Continued from page* 139)

PORTLAND CEMENT.

SIR,—I have resolved, after consideration and with your permission, to reply to Mr. Neate's communication in your last issue, and more particularly as he has had at least the manliness to put his name to it. I shall therefore go into the points of his letter, and with as much conciseness as possible.

He first speaks of "the wonderful process described." I certainly did not describe any process. I drew attention to the great quantity of carbonic acid that was allowed to go to waste, to its value, and to the manner in which bye-products were recovered in some other industries. By thus condemning a process which was not even described, Mr. Neate clearly shows that, from whatever reason, he was writing under prejudice. The second point in his letter, with its personal allusions, I shall entirely pass over.

In regard to the third point, all that I need say is that by proper management the organic matter can be destroyed, and that pure carbonic acid can be and has been produced or recovered during cement-making.

Under the fourth head Mr. Neate speaks in a very positive manner and gives temperatures. As to retorting slurry at a temperature of 2000 deg. C. I need say nothing. As for first retorting to expel the carbonic acid, with subsequent calcination in kilns, I may inform Mr. Neate that a temperature of about 800 deg. Fah., not Centigrade, suffices for the operation, provided that the slurry has been previously subjected to mechanical treatment. I may further state that slurry can be prepared which is not friable after being retorted, and as for "insuperable" difficulties, they would be less than those entailed every day or night of the year in the numberless gas works of the country. I may add that there are persons who consider that a previous retorting, or other treatment of the slurry, before being passed on to the kiln would be an advantage, even apart from any question of the recovery of the carbonic acid. Slurry which had been freed from its water and carbonic acid could be subjected to the full heat of the kiln in a short time. Thus the kiln would only require to do its own work, namely, the proper clinkering of the materials.

We come to the fifth point. Mr. Neate is evidently not aware that there are large works in operation in which the production of carbonic acid is carried on, not as a bye-product, but as the chief or only article of manufacture. I think Mr. Neate would find on inquiry that the process carried on in these special carbonic acid works is not of the extremely simple nature which he describes.

Rochester, February 12th. JAMES MORRIS.

LIGHT AND THE BENHAM TOP.

SIR,—Several months have elapsed since you permitted me to direct attention to several defects in the accepted and enunciated wave theory of light. I do not find that my objections were combated seriously; indeed, it was difficult, with Dr. Lodge's admissions available, to dispute the soundness of my conclusions. Since I wrote many things have occurred in science, and Mr. Benham, by his experiments, has, I think, driven another nail into the coffin of the wave theory. Briefly stated, the wave theory says that white light is made up of colours called primary, and at one time said to be seven in number, the number has been reduced, but that does not affect the matter. Each colour is supposed to have a different wave length, and the prism and the diffraction grating possess the power of dispersing radiant rays and separating the different wave lengths; but how or why no one knows, all attempts of the pure physicist to explain being refuted by the mathematician.

Mr. Benham provides a disc top with a black and white card, the black and white being arranged on a definite scheme, and when this disc is caused to revolve with sufficient rapidity we get, not a grey, but colours. In a word, the top can give us the spectrum. To all intents and purposes, then, we have here proof that colour is not due to wave lengths, but to light and darkness repeated with sufficient rapidity on the retina. Up to the present I have seen no attempt at an explanation of the phenomena consistent with the wave theory that is not open to fatal objection. But it seems to me that the results are readily explained by a modification of Newton's corpuscular or emission theory. Let, for example, a dozen marbles drop on the floor. As each impinges it represents light. The interval between any two impingements is darkness. The colour impression varies through the whole range of the spectrum with the rapidity of succession in the impingements.

It would be premature to do more than direct attention to the facts and suggest a theory at present. I should like, however, to hear what your mathematical correspondents, Captain Bassevi, for instance, may have to say on the subject. M. A.

Woodstock, February 5th.

RAILWAYS IN CEYLON.

SIR,—In a recent issue you quoted from a German source certain statistics relating to the working of the railways in Ceylon. As part of the quotation made by you is likely greatly to mislead your readers, it seems desirable that the mis-statement made should receive correction. The paragraph stated, in the first place, that there were but few through-bookings between India and Ceylon. This would seem to presuppose that the uniting railway proposed between the island of Ceylon and the mainland was already completed. As a matter of fact, it has not yet been commenced. In apparent contradiction to this presupposition, the compiler of the statistics follows up his remarks by observing that it had become known that the proposed union of the two systems would be rendered financially impossible by the cost it would entail for altering the gauge of the South Indian railways; the fact being that this alteration has for some years past been already made. The writer was doubtless misled by the publication of a report made by Colonel Stewart some eighteen years back. For this publication with reference to present proposals the Government of Ceylon is responsible. Not being able or willing to refute the arguments of the supporters of the modern scheme, that Government unearthed from its archives this antiquated report; and doubtless the compiler whose figures you quoted deemed it to be a report that might be relied upon in opposition to present proposals, and paid no attention to the date of it. His further quotation of estimates of traffic by the Public Works Department for the Adam's Bridge Railway were from papers similarly antiquated and out of date.

Since Col. Stewart's report was made, the construction of the magnificent harbour at Colombo has entirely altered all the conditions upon which he based it. As has been written above, the change of gauge on the South Indian lines, which Col. Stewart estimated would add between 1½ and 2 millions sterling to the cost of the proposed line, has long ago been effected, while the estimates of traffic on which the compiler relied have been entirely abrogated by the changed circumstances brought about by the establishment of an enclosed harbour at Colombo.

It is not easy to understand why, at this particular juncture, the Ceylon Government should have knowingly, and without explanation, have made public reports that it must have known to be thoroughly obsolete and useless. These have, as is evident from the errors I have pointed out, thoroughly misled the public. Can it be that they were given to the world in the hope that the real issues at stake might be veiled by them? F.

London, February 5th.

FIRE-BOX STAYS.

SIR,—Will you let me ask some of your readers for information on a matter of very considerable importance to engineers and steel makers?

It happens that I make a considerable number of small locomotive type boilers carrying rather heavy pressures. For years I used scrap forged rods, or Low Moor, or other wrought iron of excellent quality, and I have had no trouble with broken stays. There have been no complaints. When steel became the fashion I followed the crowd. I have no reason to complain of cracked fire-boxes, but I have very great reason to complain of broken stays. About three years appears to be their life. Is this the experience of other boilermakers?

I have been using Siemens steel. The stays are about 3in. long between the plates, screwed all over and riveted in the usual way. The quality of the steel is such that it complies with the Board of Trade rules for marine boiler work. If the experience of others is like mine, the sooner we go back to iron the better.

I shall be much obliged for any information that can be supplied by steel makers or others. Is there any particular way in which a steel stay should be made? Mine are not heated or forged in any way, the Board of Trade warning us against that practice. They are cut off the bar as delivered by the makers and screwed in the ordinary way. To satisfy you that I do not ask questions to gratify curiosity, I enclose my card, from which you will see that this question of stays is no trifle, but for obvious reasons I do not wish my name made public. STAY BOLT.

February 12th.

S.S. NORTH-WEST.

SIR,—Observing in your issue of the current week an account of the above steamer, fitted with Belleville boilers, that there are 812 square feet of fire-grate and 22,736 square feet of heating surface, for a total indicated horse-power of 7500, these figures work out 9·236 indicated horse-power per square foot of fire-grate and 3·03 square feet of heating surface per indicated horse-power respectively.

Assuming that there is no error in the report as published in your columns, it would appear to me that very large boilers on this plan are required, as compared with those on the ordinary Scotch type. MARINE ENGINEER.

London, February 12th.

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

Tests of roofing slates.—At a recent meeting of the American Society of Civil Engineers, a paper on the strength and weathering qualities of roofing slates from Pennsylvania was read by Professor Merriman, of Lehigh University, in which it was stated that these qualities depend not merely upon the chemical constituents, but upon the way in which the grains are cemented together, which can only be ascertained by microscopical examination. The tests were made by impact, a simple test for quick use by architects and builders. The test pieces were 6in. by 7⅞in., with the ends loosely clamped in grooved supports, so as to form a beam with fixed ends. A wooden ball weighing 15⅝ oz. was dropped from a height of 9in., and the number of blows required to produce rupture were noted. The number of foot-pounds of work required per pound of slate in causing rupture is a measure of the ultimate resilience of the material to resist shock, and is thus an index of its strength and toughness. In the acid tests the results showed that specific gravity is not a good index of corrodibility, but also that the least corrodible slate offers the greatest resistance to impact. The tests for density and softness, although of importance for slates of the same locality, are not good indications of the strength and weathering qualities of slates of different regions; but tests for porosity, corrodibility, and flexural strength give good indications of these properties. The injurious chemical constituents are sulphur, carbonate of lime, and magnesia, but while chemical tests are valuable, only physical tests can be relied on for authoritative information as to wear and use. The compressive strength of 3in. cubes is 5360 lb. per square inch when the pressure is applied parallel to the cleavage, and 10,530 lb. when applied perpendicular to the cleavage.

Torpedo boats.—The Navy Department is now receiving tenders for the construction of three torpedo boats, each 160ft. long, 16ft. beam, and 5ft. draught, with a displacement of 139 tons, sixty tons of which are for the machinery. The total coal capacity is forty-five tons. The armament consists of three torpedo tubes and three one-pounder rapid fire Hotchkiss guns. The torpedo launching tubes are mounted on deck on swivel carriages, and it is claimed that the boats operated on this plan can handle their torpedos more rapidly than boats having the torpedo tubes built in the bow. The tubes of the latter being much nearer the water-line, it is necessary for them to slow down to discharge their torpedos, and the necessity of turning after firing lessens their chance of escape. The steam generators in these boats are placed at the ends of the machinery space, with the twin screw engines between them, one ahead of the other, in water-tight compartments. By this arrangement—the engine-rooms being separated by a bulkhead—much more comfort is obtained for the engineers, and a shot piercing the vessel from side to side cannot disable more than one engine or cause the abandonment of more than one engine-room, unless it should happen to exactly strike and wreck the bulkhead. When running at cruising speed one engine watch can manipulate both engines, as the throttles and reverse gears are at the ends of the engines nearest the bulkhead, which is pierced by a door that can be closed water-tight from the deck above. Powerful steam ejectors are placed in each compartment, capable of relieving the vessel of an immense amount of water in a short time. The engines themselves are specially designed for lightness and strength. They are of the vertical, inverted cylinder, direct acting, triple expansion type, each having a high-pressure cylinder 12in. diameter, an intermediate pressure 19½in., and two low-pressure cylinders 22in., all with a stroke of 16in., developing at a steam pressure of 240 lb. 2000-horse power when making 412 revolutions per minute. The arrangement of working parts is such as to reduce vibration to a minimum. The principal bearings are extremely long, and every possible place is cored and bored out, so that the horse-power per ton of weight of material is very high. The working parts have also been reduced in number as much as possible, the main valves, all of the piston type, being worked by means of cranks on a shaft parallel to the main shaft and geared to it. Each engine will have its own condenser, and these will be placed on opposite sides of the engine compartments. The boilers are of the water-tube type, quick steamers, and carry their high-pressure wonderfully steady and without foaming or priming. On deck the turtle-back is carried from the bow to the forward side of the conning tower, which enables these boats to keep up a high rate of speed, even in a sea, and also adds to the space of the officers' quarters. Contrary to the general rule, these are placed forward, near the conning tower, and are fitted to afford the greatest comfort in the least space, every effort being made to spare both officers and crew as much as possible the fatigue and inconvenience common in such small, high-powered craft, and keep them in an efficient fighting condition. The entire space aft of the machinery is given up to the machinists and crew, and fitted with folding berths, mattresses, and lockers, and supplied with a lavatory and yacht water-closets. Two methods of steering are provided—steam gear in the forward conning tower and hand gear aft, beside a spare tiller placed near the rudder head to be used in case of an emergency. The after tower is oval in shape, and forms a covered companion-way and ventilator to the spaces below, as well as a chart and navigation room. On the deck beside the torpedo tubes are two one-pounder Hotchkiss guns, and another one is mounted on the forward conning tower. Folding boats are carried; also a small mast, not rigged to carry sails, but merely for the display of signals—flags by day and electric lanterns by night. The anchors are handled from davits near the forward end of the turtle-back by a neat little steam windlass sunk in the deck. No planking is used on the decks; they are covered with thick linoleum instead, as this gives a better foothold in wet weather, and is much lighter than wood. Electricity is used for general illumination, as well as for running side lights. The ventilation system is very complete, consisting of downcasts and exhausts for each compartment, the hatches and skylights by proper construction being also utilised for this purpose.

PHYSICAL SOCIETY.

AT the ordinary meeting, January 25th last, Mr. Medley concluded the reading of a paper by Professor Ayrton and himself on "Tests of Glow Lamps," which was commenced at a former meeting. With the newer lamps employed in these tests it was found that candle-power, current, and candles per watt all rose as the lives of the lamps increased. The authors, being surprised at this result, took care to satisfy themselves that the effect observed was due neither to change in the resistance of their manganin potentiometer strip, nor to uncertainty of contact at the sockets of the lamps. Starting again with new lamps, they found that in all cases the light given out was greater after the lamps had been glowing for some time than it was when they were new. In the earlier tests a considerable falling off in candle-power had always taken place after the lamps had been running for some time. Further, while the globes of the earlier lamps were always much blackened, even after a run of a few hundred hours, and so became comparatively useless long before the filament broke, the Edison-Swan lamps now examined showed hardly any blackening, even when the filaments lasted over 1300 hours. The rise in candle-power was always accompanied by a rise in current, which was, however, proportionally much smaller, so that the consumption of power per candle was actually less after the lamp had been running fifty hours than it was at the beginning. Among the conclusions drawn by the authors were the following:—(*a*) When a group of Edison-Swan lamps marked 100-8 are run at 100 volts, and each lamp as its filament breaks is replaced by a new one, it may be assumed that the light given out will never subsequently be as small as when all the lamps were new; (*b*) an Edison-Swan lamp marked 100-8, when run at 100 volts will give an average illumination of about 10 candles, and will absorb on an average power of about 4·3 watts per candle, so that such a lamp must be regarded as a 43-watt lamp, and not a 30-watt lamp, as is frequently stated; (*c*) the maximum rise of light recorded during the life of any lamp was 45 per cent.; (*d*) with lamps of the type examined, there is no point at which it becomes economical to discard a lamp before its filament actually breaks; (*e*) no marked economy can be gained by over-running such lamps, *i.e.*, by using pressures exceeding 100 volts.

Professor Ayrton mentioned that the improvement in glow-lamps after running for some time had been attributed to an improvement in the vacuum. Experiments made on new and used lamps by means of an induction coil showed that the more a lamp was used the better the vacuum became, but he—Professor Ayrton—though at first inclined to adopt this explanation, had since found that though in all the lamps examined the progressive improvement of the vacuum was equally marked, the increase in candle-power varied between very wide limits, being very considerable in some lamps, and hardly perceptible in others.

Professor Rücker asked if it made any difference to the life of a lamp whether it were kept running continuously until the fibre broke or were run for periods of a few hours, alternating with intervals of rest. The latter case would more nearly correspond with the conditions obtaining in practice.

Professor Ayrton replied that the lamps were kept running during the night, and were disconnected during the day.

A paper by Professor Anderson and Mr. J. McClelland, on "The Temperature of Maximum Density of Water and its Coefficient of Expansion in the Neighbourhood of this Temperature," was read by the secretary, Mr. Elder. The dilatometer method was used, but the bulb of the instrument contained a quantity of mercury, determined by experiment, which for the range of temperature concerned was such as to secure the constancy of the remaining internal volume occupied by water. The observed changes were thus the real and not the apparent changes. The bulb was furnished with a graduated tube of small bore bent twice at right angles, which serves at the same time the purpose of a ground glass stopper. The joint was made water-tight by a little Canada balsam. To determine the coefficient of expansion of the glass, the bulb and tube were filled with mercury at 0 deg. C., and heated up to about 9·7 deg. C., the necessary weighings being afterwards performed. The coefficient of expansion of mercury being known, the number of grams of mercury to be kept in the bulb during the experiments on water was calculated. The dilatometer was next filled with thoroughly boiled distilled water at about 8 deg. C., the stopper-end of the graduated tube inserted, and the free end dipped under mercury, giving at 4 deg. C. a column of mercury whose changes of level could be observed. A thermometer was placed with its bulb close to the middle part of that of the dilatometer, both being immersed in a water bath which could be cooled by the addition of ice-cold water or cooled by radiation from surrounding objects. The thermometer used was graduated to tenths of a degree, and was compared with two similarly graduated ones by different makers. The two latter agreed very closely with one another, and one had a Kew certificate showing no error in the readings. Temperatures were written to the fourth decimal place, but accuracy to this extent was not claimed. Three sets of experiments were made, and for each a corresponding curve was drawn. In the first the water was at atmospheric pressure, in the other two at one and a-half and two atmospheres respectively. Corresponding to these three pressures the temperatures of maximum density found were 4·1844 deg. C., 4·1823 deg., and 4·1756 deg. The value 4·1844 deg. corresponding to atmospheric pressure, is greater than that generally received.

Mr. Rhodes thought that sufficient precaution had not been taken to calibrate the thermometers accurately. He doubted whether temperatures read in the manner described could be relied upon to much less than 0·1 deg. He did not see that any real advantage was gained by having mercury inside the dilatometer to compensate for the expansion of the glass.

Mr. W. Watson thought that the mercury within the vessel would cause further uncertainty by tending to produce distortion of the glass. He pointed out that in the case of water at maximum density there would be practically no convection currents, so that equalisation of temperature would be very slow. As the bulb used was about 8 cm. in diameter, and all the experiments were made with the temperature rising, he thought that this would account for the high value obtained for the temperature of maximum density.

Dr. Burton thought a distinct advantage was gained by compensating for the expansion of the glass. The values obtained in different experiments did not seem to be highly concordant.

Prof. Rücker thought that the criticisms which had been passed were for the most part just. For such measurements as those recorded, it was not sufficient to know the corrections of the thermometer readings at a few isolated points; the portion of the stem over which the readings were taken must be carefully and minutely calibrated. The Kew certificate not only ignored errors of less than ·05 deg.—as mentioned by the authors—but it only gave corrections for a small number of temperatures, separated by considerable intervals.

ALTHOUGH H.M.S. Sultan has undergone a thorough refit, and is supposed to be to a large extent modernised, we read that her old muzzle-loading guns are to be retained. We cannot but deplore the tendency to do things by halves thus made evident on the part of the Admiralty. So much money has been spent on this ship since she was brought home from the Comino Channel that one would like to see a better result.

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

(*From our own Correspondent.*)

A STRONG commercial position in such times as these, is that occupied by the Patent Nut and Bolt Company, of Smethwick, near Birmingham. The annual report proposes to pay a dividend of 5 per cent. on the preference and 10 per cent. on the ordinary shares, to place £10,000 to the reserve fund—thus bringing it up to £100,000—and to carry £21.000 to the next account. The net profits for the year were £42,329. A satisfactory report is given also by the Birmingham Railway Carriage and Wagon Company, who pay 6 per cent. on the preference, 7½ per cent. on the ordinary, and whose reserve and depreciation fund now stands at £106,514. Perry and Co. have made £28,000 profit for the year, and pay 5 per cent. on the preference, and as much as 12½ per cent. on the ordinary shares. This is decided progress.

The iron trade shows little trade this week in its actual condition, business being greatly interfered with by the continuance of the frost, numbers of works being unable to get coal, and the canals being completely blocked with ice. The meeting to which reference was made last week, for forming a New Midland Iron Trade Association, has resulted in the issue of circulars to the various ironmasters in the districts, describing the scheme and asking for their co-operation. The proposal does not, however, meet with any large amount of enthusiasm, and many of the ironmasters are of the same view as that expressed by Messrs. Pearson and Knowles, of Warrington, who suggest that the present time is scarcely opportune for action by combinations aiming at advancing prices. Messrs. Pearson and Knowles fear increasing foreign competition from Belgium, Germany, and other countries, and they urge that the only way to meet this competition is by cheapening production.

The possibility of a ship canal from Birmingham to the coast is a prospect calculated to raise anticipations of lightened freightage bills in the minds of many Midland engineers, whilst the construction of such a waterway is a no less inviting subject for the imagination to dwell upon. The attention which is being given to the subject seems to point to something practicable being accomplished before many more years have passed. No fewer than four papers on the subject of canals *v.* railways were contributed at the morning session alone at the seventeenth annual meeting, held in Birmingham this week, of the Federated Institution of Mining Engineers; and in the afternoon two other papers were read, dealing more particularly with Severn navigation. Mr. L. B. Wells, of Manchester, pointing out that the railway companies control 1264 miles of navigation out of 3520 miles, advocates a scheme for transferring canals to independent companies, and then for the amalgamation of the canal companies and a wholesale improvement of all British waterways. Regarding the low cost of plant for water transit, he points out that a railway train loaded with 220 tons costs for locomotive and trucks £3360. A steam barge to carry the same quantity would cost £1600, but it could be used to tow three other barges of 260 tons capacity, costing £800 each, and not merely in the still waters of the Weaver and Manchester Ship Canal, but also across the estuary to Liverpool. Mr. E. D. Martin, engineer to the Severn Commissioners, showed that for an expenditure of £10,000 the thirty miles of the Severn from Gloucester to Worcester had been converted from a mere barge canal into a highway for sea-going steamers, and the Midlands had been brought thirty miles nearer the ships' side. Mr. L. F. Vernon Harcourt suggested several sea routes from Birmingham, at an estimated cost of £5,000,000; but one estimate during discussion was only £2,317,450 from Birmingham to London.

The Birmingham Association of Mechanical Engineers had a pleasant and instructive time at their annual dinner on Saturday, when the chief guest was Mr. Jesse Collings, M.P. The chairman—Alderman Fallows, Mayor of Birmingham—proposed prosperity to the Association. Considering it had been established only five years, he thought the membership was satisfactory, and the yearly increase in numbers clearly showed the favour with which it was regarded. Mr. E. Hazel, president, in replying, submitted that the association, by the useful work it carried on, was in every sense worthy of the attention and countenance of every engineer employer in the district. That and kindred associations were doing their best to conserve to England the heritage of a race of engineers, and to keep her in the proud position of the mother of engineering nations.

To the representatives of iron and steel and engineering works present at the recent meeting of the South Staffordshire Institution of Iron and Steel Works Managers, an interesting account of the rise and progress of the Factories and Workshops Acts, was given by Mr. C. C. Hoare, H.M. Inspector of Factories for this district. Most of the paper was historical, and Mr. Hoare wisely refrained from lecturing his audience upon their duties, but he concluded with a few hints, which may be usefully reproduced. It behoved, he said, many employers in Staffordshire seriously to study the best means of carrying out the section of the 1878 Act as to providing fans or other mechanical means for removing dust generated by grinding, glazing, or polishing. Each man should be made responsible for his own fencing. In more than one instance he had instituted legal proceedings against rollers for neglecting to keep the fencing of their rolls in proper condition when the owners of the ironworks had directed the men to do this. Mr. Hoare also asked his hearers to see that the abstract of the Acts was in good order, and that all notices of night work, holidays for day workers, &c., were fixed in conspicuous positions. They must not allow lads to be employed, especially those on night turn, unless their names were duly registered.

The question of bogus certificates in the chain trade is not to be allowed to go unanswered. The matter has now been taken up by the United Chain Makers' and Chain Strikers' Association, who are preparing a report to be forwarded to Members of Parliament for all British districts concerned in making chains "for British ships or for use within the United Kingdom." It is declared that these "spurious chains are chiefly made by persons belonging to other trades, who work at night in out-shops." It is asserted that "large quantities of chains are manufactured in Staffordshire and Worcestershire that are utterly unfit to be sold in the markets, and which would not stand the Admiralty test." The buyers depend upon bogus certificates which allege that a test has been applied.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—There is still no new development calling for special notice in the general position throughout the iron trade of this district. In pig iron for the most part business continues mostly of a hand-to-mouth character, consumers buying fifty tons where they usually buy five hundred; but if anything, there is perhaps more firmness on the part of makers in holding to their prices, and merchants are more chary about underquoting. Here and there where special offers of quantities are put forward makers will give way 3d. or 6d. per ton, but generally it is becoming difficult to place orders at under current quoted rates.

Lancashire makers state their position to be precisely the same as I have reported for several weeks past, and with regard to district brands 36s. to 36s. 6d. for forge to 38s. to 38s. 6d. for foundry remain about the average figures for Lincolnshire, with Derbyshire foundry about 42s. 6d. to 43s. net cash, delivered Manchester. For good foundry brands of Middlesbrough makers are not quoting under 43s. 4d. to 43s. 7d. net cash, delivered Manchester, but sales at 3d. to 6d. under these figures have recently been made by merchants. With regard to Scotch iron it would be difficult, except through a few speculative operators, to place orders for Eglinton under about 46s., and for Glengarnock about 46s. 6d. net prompt cash, delivered at the Lancashire ports.

Finished iron makers in this district still report forges on short time, and good specifications could be placed at under quoted rates. Delivered Manchester or Liverpool, Lancashire bars average £5 3s. 9d. to £5 5s., with North Staffordshire qualities quoted £5 5s. to £5 7s. 6d.; Lancashire and Staffordshire sheets, £6 15s. to £7; and Lancashire hoops, £5 15s. for random, and £6 for special cut lengths.

The movement amongst the ironmasters of Lancashire, Staffordshire, Yorkshire, Shropshire, and Derbyshire, with the object of forming a combination with the workpeople—to check what is described as "the downward and ruinous tendency of prices" in raw and finished iron—is not likely to attain very successful results in face of the opposition of Messrs. Pearson and Knowles, in Warrington, the largest finished iron makers in Lancashire. Messrs. Pearson and Knowles strongly hold the opinion that the only way to meet German and Belgian competition is to cheapen production, and this view is shared by a great many of the leading representatives of the iron trade in this district with whom I have discussed the matter. Possibly some combination might be arrived at with regard to purely home trade, such as the hoop manufacturers have carried out for the last two or three years, but which has tended to shut them out of the foreign markets, and a combination such as proposed by the ironmasters would inevitably have the effect of still further restricting the foreign trade.

Business continues only very quiet as regards either raw or manufactured steel; for ordinary foundry hematites the average prices remain at about 51s. 6d., less 2½ per cent., with common steel billets obtainable £3 17s. 6d. to £4, and better qualities £4 5s. per ton, net cash, delivered Manchester. The position of makers of steel boiler-plates is, however, somewhat strengthened by the large orders which have recently been booked in Scotland, and which will necessarily tend to check the keen competition of Scotch plates in this market. There is still only a limited local demand, but prices are becoming firm at £6 to £6 2s. 6d. as the very minimum figures for good boiler-making qualities, delivered Manchester district. In steel bars, however, some contracts have recently been placed at extremely low figures.

I hear several important orders have recently been secured by one or two well-known machine-tool makers in this district. One of these is for Japan, another for Russia, and there seems to be a very fair amount of contract work just now stirring on account of both home and foreign Governments. Apart, however, from this I do not come across any appreciably increased weight of new work coming forward; and where establishments are not securing special orders for contracts such as above referred to they are mostly but moderately engaged. Boiler makers still report this branch of trade as anything but satisfactory, and the locomotive building trade also remains without improvement, the principal establishments in this district being very short of orders.

The annual report of the Wigan Coal and Iron Company, the largest concern of its kind in Lancashire, has just been issued to the shareholders. The directors stated that the output and sales from the collieries have been greatly restricted owing to the small demand for fuel, and the pits unfortunately have been working very short time owing to the impossibility of vending the fuel at a reasonable price. In fact the pits have never before worked such short time, since the formation of the company. During the early part of the year prices were still somewhat abnormal, but they soon began to fall, and this had continued through the year. The demand both for iron and steel had also been very dull during the twelve months, with prices quite unremunerative. The accounts for the year showed a profit of £82,922 on the whole operations of the company, and the directors recommended a dividend at the rate of £4 per annum free of income tax, which would absorb £72,389, leaving a balance of £12,663 to be carried forward.

The continued excessive severity of the weather is necessarily keeping up a brisk demand for all housefire qualities of fuel, and with a few exceptions collieries are securing sufficient orders to keep them on practically full time. The frozen condition of the canals is, however, considerably interfering with water transit, with the result that a largely-increased traffic is thrown upon the railways, which they are not in all cases fully able to cope with, and in not a few instances large users of fuel for manufacturing purposes are experiencing some difficulty in getting their requisite supplies. The commoner qualities of round coal, although they do not meet with any appreciably increased demand for iron making, steam, and general manufacturing purposes, are moving off more freely for house fire requirements, with the result that a good deal of the surplus supplies are taken off the market, whilst engine fuel continues in generally good demand for mill purposes. The spell of severe weather has, however, come too late in the season to enable colliery proprietors to put up their prices, but they are firm at full list rates, best Wigan Arley at the pit mouth readily fetching 10s. 6d. to 11s. Pemberton 4ft. and seconds Arley, 9s. 6d. to 10s.; common house-coals, 7s. 6d. to 8s.; steam and forge coals, 6s. 6d. to 7s.; with engine fuel ranging from 3s. 6d. for common, to 4s. 6d. and 5s. for better qualities.

The shipping trade continues only quiet, but with lessened supplies offering at the ports on the Mersey, the excessively low quotations recently ruling have for the moment disappeared, and ordinary descriptions of Lancashire steam coal could scarcely be bought under 8s. to 8s. 6d. per ton, delivered at the Garston Docks or the High Level, Liverpool.

Barrow.—The hematite pig iron trade is very inactive, and the position is made much more serious this week by the fact that five furnaces have had to be damped down at Millom and Askam, in consequence of the unsuccessful efforts made between masters and men as to the terms on which a reduction of wages can be brought about. Further than this, a furnace has been blown out at Harrington, in Cumberland, and now there are only twenty-three furnaces in blast in the district out of seventy-five which are built. Notices of reduction in wages have been given at the Barrow Steel Works, varying from 5 to 7½ per cent. It is not anticipated there will be any difficulty here, as work is so scarce. Prices of pig iron warrants are rather higher at 42s. 4d. net cash sellers, and 42s. 3d. buyers. Makers quote 43s. to 44s. per ton net f.o.b. for mixed Bessemer numbers. Stocks have increased during the week 500 tons, and now stand at 185,247 tons, or 14,769 tons more than in the beginning of the year.

Iron ore is in slower sale than ever, and, of course, in very small consumption. Prices are steady at 8s. 6d. for ordinary, 9s. to 10s. for best, and 12s. to 13s. 6d. per ton net at mines for picked qualities.

Steel makers are short of work, and some good orders have just gone past them at lower prices than makers in this district can afford to quote. There is a poor demand for rails. Plates are in fair order, but no new contracts have been booked lately. Steel castings are in good demand, and makers are well placed for orders. Other branches of the steel trade are depressed.

Shipbuilders and engineers are not booking any new orders, but remain very busy on old contracts for Admiralty and mercantile account.

The coal trade is depressed, and sales are fewer than they have been. Prices are unchanged at 12s. to 14s. per ton, while coke is in very limited demand at 17s. per ton, delivered.

Shipping is still very greatly depressed. Exports of pig iron during last week from West Coast ports only reached 1900 tons, comparing with 6804 tons in the corresponding week of last year, while the exports of steel were 5607 tons, compared with 3230 tons in the corresponding week of last year. The aggregate shipments of pig iron and steel this year, so far, have been 26,728 tons, and 31,495 tons respectively, comparing with 34,852 tons and 29,365 tons in the corresponding period of last year, a decrease of 8124 tons of pig iron, and an increase of 2130 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE present condition of the coal trade is very perplexing. The continued severe state of the weather is slowly telling on the demand, although the quantity called for is not large enough to keep all the collieries fully employed. Merchants' stocks are also rapidly decreasing, and the coalowners are beginning to hope that they will feel at last a part of the benefit of the increased trade. Up to now business has been met from stocks, but, as stated before, owing to their rapid decrease, agents in London have been able to advance prices in the best qualities of household fuel to the extent of 2s. per ton. The metropolis is taking a very large tonnage, and this has enabled a pretty general advance of quotations at the pit. The cheapness of other fuel makes it extremely difficult even to sustain such a small advance as 6d. per ton. With these exceptions prices are about the same as reported last week. Silkstone house coal is quoted at 9s. 6d. to 11s. per ton at the pits; Barnsley House makes from 8s. 6d. to 9s. 6d.; other qualities from 7s. 9d. per ton. There is only a moderate business doing in steam coal, and a limited amount is at present being sent to the Humber ports. Many of the leading collieries are forwarding a good supply by rail, the extreme cold weather having prevented owners using the waterways.

During last week a meeting of the South Yorkshire Steam Coal-owners' Association was called to consider the question of making contracts for the export trade; the proceedings were conducted in private. It is understood that an effort will be made to maintain a rate of 7s. 6d. per ton of 20 cwt. for best qualities. A fair business is being done with Grimsby, but it is considerably hampered by the large quantity of fuel sent from the Derbyshire collieries. Barnsley hards make from 7s. to 7s. 9d. per ton; other qualities from 6s. 9d. to 7s. per ton. Gas coal continues in good request, which is undoubtedly owing to the large quantity used for heating purposes. Prices are firmer, but abundant supplies prevent any substantial increase being obtainable. Railway companies are drawing large tonnages, and collieries having locomotive contracts on hand are extremely well off at present. Small coal, engine fuel, and slack continue in the demand already reported, and can be had at low rates. Good riddled slack is quoted at 4s. to 4s. 6d., and ordinary pit slack as low as 2s. 6d. to 2s. 9d. per ton. The coke trade is not quite so good as it was. Owing to the quiet state of the iron trade, the amounts sent to Derbyshire, North Lincolnshire, and other districts is only moderate. The output is still large, prices varying from 9s. to 10s. 6d. per ton.

No improvement is perceptible in the iron or steel trade this week. Hematites are quoted at 49s. to 51s. per ton, according to brand; bar iron, £5 to £5 5s; Lincolnshire forge iron, 38s.; Bessemer billets, £5 7s. 6d.; Siemens-Martin, £5 10s. to £6; tires and axles, £7 to £7 10s. Rather more is doing in railway material, such as springs, axles, tires, and similar goods.

The returns of the Board of Trade for January disclosed, as was expected, a considerable falling-off in imports and a slight increase in exports, as compared with the opening month of 1894. The imports amounted to the value of £36,753,068, against £38,458,613. The decrease on the month was therefore £1,705 545. The exports reached a total of £18,224,236. against £18,151,880 for January of 1894, the increase being £72,356. The foreign business done in hardware and cutlery amounted to £149,617, as compared with £149,436, thus showing a trifling advance last month. The increasing markets are Russia, Holland, Belgium, United States, Chili, Brazil, and the Argentine Republic. Decreases are shown by Sweden and Norway, Germany, Spain and Canaries, Foreign West Indies, British Possessions in South Africa, Australasia, British Possessions in East Indies, and British North America. In steel the falling-off is even more than was anticipated, the value sent abroad last month being £107,648, against £137,701. This is within about £50 of the trade done in the opening month of 1893. The principal decreasing markets are Russia, Sweden and Norway, Germany, Holland, France, British East Indies, Australasia, and British North America. In fact, only two markets exhibited an improvement—Denmark, which has advanced from £2933 to £3194 and the United States, which has taken a value of £18,296, against £14 962. But even the increased business done with the United States is still about £8000 less than in the opening month of 1893.

The coal trade of the South Yorkshire collieries with Hull during January reached a weight of 142 576 tons, as compared with 145,008 tons for the opening month of 1894. Denaby Main is again at the top with 17.360 tons, against 15,312 tons for the first month of last year. Wharncliffe Silkstone comes second with 10,680 tons, a remarkable advance on January, 1894, when the total weight sent from that colliery was 2624 tons. A West Riding Silkstone is third with 7696 tons, as compared with 4592 tons, and Carlton Main follows with 6976 tons, against 5664 tons. The foreign trade took 53,773 tons, which is an increase of 5000 tons on January of last year. Sweden and Norway, although heading the list, did far less business than a year ago, the respective tonnages having been 11,342 and 21,250. Germany, on the other hand, took 10,466 tons, against 4023 tons. South America has dropped to 2555 from 6109. Belgium has advanced to 2309 tons, only 905 tons having been sent to that market in January of last year. Egypt, France, and Holland have all largely increased their tonnage. North Russia has taken 2551, against 1401, while Africa, which did not receive a single ton of coal from England in January of 1894, took 1305 tons last month. The quantity sent last month to Africa is about one-fifth of the entire weight sent to that market in 1894. South America figures in the list for 2555 tons, an immense falling-off on the figures of the previous January, when it was 6109 tons.

Although it is generally conceded that unless a hard frost comes before Christmas it is of little use to the skate manufacturer, there can be no doubt that the long spell of almost uninterrupted cold weather has moved the entire stocks from the shelves, both of dealers and of makers. This will affect the business for next year in two ways—first, by getting rid of the accumulations, which have become considerable, owing to a succession of mild winters; and second, by encouraging local firms to prepare for frosts, which come unexpectedly as this did, immediately on the close of the old year. Several of the manufacturers state, however, that a great deal of the business is in the inferior and low-priced goods, in which Germany dominates the market. The principal of one of our largest houses has had a letter from his traveller in the London district, who says that he could not do any business in the cheaper classes, because the Germans undersold him in all these qualities. In fact, the dealers told him they had given up buying English-made skates of the more popular sorts, because they were unable to get quotations anywhere near what were readily offered by the competing German houses. The better classes of skates, particularly in recent patents, which have proved successful, are pretty largely produced by Sheffield houses, as well as the Acme skate, which is indispensable in the United States. But the production of the Acme has ceased to be a large trade in this city, the Americans having been able to overtake the most of it.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

VERY little movement is shown in trade just now, but it is satisfactory to state that it is not worse than it has hitherto been this month, which is as much as could be expected, taking into account the exceptionally severe weather, which is stopping deliveries on every side, and forcing makers to keep in their yards iron which has been bought and should have been delivered. The state of affairs is most disappointing, for when there was a reasonable prospect of improvement, as there usually is in February, the bad weather intervenes, and producers are doing no better than they did in January. Shipbuilders have booked a fair number of orders recently, and for very large vessels, and are in many cases better off for work than they were at any time last year; but they cannot get on with it, as nearly all outdoor employment has to be suspended because of the inclement weather, and accordingly, shipbuilders being unable to accept delivery of the iron and steel which they have bought, there is irregular work at the mills and forges, and the consumption of pig iron is curtailed, the stocks having to be added to in consequence. Local consumption will not this month even equal that of January, though the sales are actually better, and the increase in stock will not be very far short of that of last month if the weather does not quickly improve. But makers are not reducing production, as they believe that increased trade will be done next month when the shipping season opens, and that there will be a considerable amount of briskness. The exports to all quarters are much below the average, but then it must be remembered that all the ports on the Continent, to which this district sends the bulk of the pig iron that is shipped oversea, are icebound, and that the shipments foreign are much below even what they were last month, while to Scotland the quantity of Cleveland pig iron that is despatched from the Tees is not half the usual tonnage, for already as much iron is stored at Grangemouth as can be accommodated, and most of it must remain there until the frost disappears and the canal to the Glasgow district is open. In the ordinary course of business continental consumers and merchants should now be commencing to buy iron for spring delivery, but there is very little inclination to do so at present, as the market is so uncertain, and buyers wait on the chance of seeing lower prices, especially as some merchants abroad are said to have sold Cleveland iron at rates below any which have yet prevailed, and if they have to cover at the prices that now rule, they will be losers. It is not expected that there will be much buying for forward delivery until this month is over, but the general opinion in this district is that we have seen the minimum of prices, and that exports will be brisk as soon as the weather is propitious. This month to Wednesday night the shipments of pig iron from the Tees reached 20,044 tons, as compared with 19,547 tons in January, and 33,531 tons in February last year to 13th, but the weather of this month last year was very different from that which has been experienced this month. It is the belief that there will be much activity in trade next month that keeps makers from blowing out any furnaces and reducing the production, though at present they are accumulating stock almost as rapidly as they did in January. But they are holding the iron themselves, and much less is sent into the public warrant stores than might be expected, for Connal's increase this month has only been 100,650 tons, the quantity of Cleveland pig iron held on Wednesday night being 1808 tons.

Business in No. 3 Cleveland pig iron has this week been done generally at 34s. 6d. per ton, for prompt f.o.b. delivery, and nothing below that has been taken. It is chiefly merchants who have been selling at this price, the makers generally asking and in many cases getting 34s. 9d. Buyers are ready enough to give this for deliveries to be made over the next two months, but makers are much less anxious to sell than might be expected, judging from the rapidly increasing stocks; they, however, believe that business will be brisk next month, when the navigation season opens, and they look forward to getting rid of some of the stock. Cleveland warrants rose 3d. per ton on Monday to 36s. 6½d. cash—the best price that has been recorded for three weeks, but the advance was not upheld, for next day 2d. was lost, and at the close on Wednesday the sellers' quotation was 34s. 4d. No. 1 Cleveland pig iron has been sold at 36s. 6d., but will realise more next month, for continental consumers who take the bulk of what this district produces will have resumed their imports of it. No. 4 Cleveland foundry pigs are at 33s. 9d., and grey forge at 33s. for prompt f.o.b. delivery. Mixed numbers of East Coast hematite pig iron are to be had at 41s. 6d. per ton for prompt f.o.b. delivery, but 41s. 9d. is the general quotation, and those who have to pay the present prices for materials can hardly expect to make any money at this figure.

If anything, business in the finished iron and steel industries is somewhat better on the whole, and, except for bars, prices are firmer. The plate and angle manufacturers report a stronger demand, and when the weather becomes milder and the shipbuilders get back to work, they expect to be able to keep their mills going with a fair amount of regularity, as they will then have no difficulty in regard to specifications. Nothing below £4 12s. 6d. is accepted for steel ship plates, while iron ship plates are £4 15s.; steel boiler-plates, £5 12s. 6d.; and iron boiler-plates, £5 15s.; iron and steel ship angles, £4 10s.; engineering angles, £4 15s.; all less 2½ per cent. disconnt and f.o.t.

The bar trade, which hitherto has felt the depression less than other departments, is now more affected by dulness, and orders are very few and for small quantities, which would indicate that the small consumers, who are the chief buyers, are badly off for work. The quotation for common iron bars is £4 15s., less 2½ per cent. Railmakers are not better off, but manage to keep their mills in regular operation.

A case of some considerable interest to iron and steel manufacturers has been tried in the Official Referee's Conrt, to which it had been referred from the Leeds Assizes. Messrs. R. Craggs and Sons, shipbuilders, Middlesbrough, claimed £1500 damages from Messrs. Dorman, Long and Co., Britannia and West Marsh Iron and Steel Works, Middlesbrough, for breach of contract. The defendants had contracted to supply during 1892 some 300 tons of steel angles, bulbs, and bulb angles of Siemens-Martin quality, to pass Lloyd's and the Bureau Veritas tests. The plaintiffs said they suffered loss by reason of the failure to deliver the steel at the proper time, and by its failure in quality. Thus they had not been able to complete a vessel in the stipulated time, and became liable to the owners. It was ultimately agreed that the measure of damages should be £500, or £300 more than had been paid into court, each party paying their own costs.

The Yorkshire Dales Railway Bill—about which so much has been heard in the North—is dead for this session, for there was no appearance when it came before the Examiner on Standing Orders at the House of Commons. The prospect of constructing a light railway in Sarledale is more encouraging, as the Chairman of the North-Eastern Railway Company has asked a deputation of the chief persons in the valley to meet him. It will cost £40,000, and it has been suggested that the local people should provide one-third, the landowners one-third, and the County Council the remaining third. At the half-yearly meeting of the North-Eastern Railway Company, Sir Joseph W. Pease, Bart., M.P., the new Chairman, said he had been on the directorate of the North-Eastern Railway longer than any other member — since the amalgamation of the Stockton and Darlington Railway with it in 1863. He was elected on the Stockton and Darlington Board in 1853, and was one of those who conducted the amalgamation of that undertaking with the general system of the North-Eastern.

The engineering industries are quiet; but some report that they are doing better than for nearly a year—in fact, they are better off for orders than they have been since the strike of engineers and moulders last year. But the worst of it is, that scarcely enough to cover cost of production can be secured from customers. There appears to be less difficulty about securing orders, and it seems likely that the worst in prices has been touched.

The deliveries of coal have increased, as shipments can now be carried on without hindrance, the weather having moderated; and the collieries, therefore, are more fully employed than they have been at any time this year. The extent to which the bad weather affected the trade may be seen in the fact that the exports of coal from north-eastern ports last month only amounted to 1,262,325 tons, or 323,373 tons less than in the corresponding period of last year. Prices are firmer, but not equal to those of February last year. Steam coal is 1s. 8d. per ton cheaper. The Swedish State Railway contracts have been placed at 12s. 5d., delivered at Stockholm, this being 1s. 5d. cheaper than last year's figure. The bulk of the coal will be supplied by this district, but some will be sent from South Yorkshire and Scotland. Coke is firm at the figure which the syndicate have for several months adhered to.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been a somewhat firmer tendency in the Glasgow pig iron market this week, with more warrants changing hands than of late. Business has been done in Scotch warrants at 41s. 3½d. and 41s. 4d. cash. Cleveland iron has been quiet but steady at 34s. 3½d. Hematites have been inactive, as far as warrants are concerned, at 42s. 3d. for Cumberland and 41s. 3d. for Middlesbrough iron.

The Forth and Clyde Canal, along which the pig iron brought from the Cleveland district into Scotland is conveyed from Grangemouth to the iron districts of the West, has been completely blocked by ice. The same thing has not occurred for a large number of years. Little inconvenience has so far resulted, however, the merchants who import the iron keeping good stocks of it, in case of such an occurrence. The stoppage of the canal has at the same time led to the suspension of work, either wholly or partly, in a variety of directions along its course, and this has been most apparent in connection with the coal trade.

One or two furnaces have been changed from the production of one class of iron to another, but the total number blowing remains 74, compared with 61 at this time last year. There are now four furnaces producing basic iron at Glengarnock.

The prices of the special brands of makers' iron have been reduced in most instances 6d. to 1s. per ton. G.M.B., f.o.b. at Glasgow, No. 1 is quoted, 42s. 6d. per ton; No. 3, 41s.; Monkland, No. 1, 43s. 6d.; No. 3, 41s.; Carnbroe, No. 1, 45s. 6d.; No. 3, 42s. 6d.; Clyde, No. 1, 48s. 6d.; No. 3, 45s. 6d.; Gartsherrie and Calder, No. 1, 50s. 6d.; No. 3, 46s.; Summerlee, No. 1, 51s.; No. 3, 46s.; Coltness, No. 1, 53s. 6d.; No. 3, 50s.; Glengarnock at Ardrossan, No. 1, 49s.; No. 3, 45s.; Eglinton, No. 1, 46s. 6d.; No. 3, 44s.; Dalmellington at Ayr, No. 1, 45s. 6d.; No. 3, 43s. 6d.; Shotts at Leith, No. 1, 53s.; No. 3, 50s.

The shipments of pig iron from Scottish ports in the past week amounted to 4578 tons, compared with 3123 in the corresponding week of last year. There was dispatched to Australia 635 tons; South America, 256; India, 132; Germany, 45; Belgium, 20; Holland, 10; Spain and Portugal, 110; China, 30; other countries, 105; the coastwise shipments being 3336 tons, against 2413 in the same week of 1894.

Scarcely any improvement appears in the demand for pig iron either for home use or shipment. At home work has been much interrupted by the severity of the weather, supplies of both water and gas having been cut off in numerous cases. In one or two of the Clyde shipbuilding yards a total suspension has taken place from this cause, and great suffering has been entailed upon numerous sections of the working classes, the building trade in particular having been at a complete standstill for several weeks.

The finished iron trade is dull, the orders available being insufficient to keep the works anything like actively employed. In the export section of the trade there is practically no improvement, and prices are unsatisfactory.

Steel makers, having failed in obtaining adequate prices, have made a claim for a reduction of 5 per cent. on the wages of the higher paid workmen. It is not proposed to reduce the others at present. The claim will be submitted to the decision of a board of arbitration, who, it is hoped, may be able to bring about an amicable arrangement.

In the coal trade there has been an active inquiry for home consumption of household coals, the prices of which in some localities have been raised to consumers. This is due entirely to the difficulty of transport, many of the railways as well as the waterways having been blocked. The shipments at Glasgow have improved, but, on the other hand, they have decreased at some of the East Coast ports. There is improvement in the trade as a whole.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

AN important meeting of colliers was held at Aberdare on Monday, when it was decided to support the candidature of Mr. David Morgan, miners' agent, for the County Council. The meeting passed a resolution strongly approving of the efforts made by the agent and executive committee in the endeavour to settle the dispute which existed amongst the timber men and rippers at the Aberdare-Merthyr steam colliery. The meeting next proceeded to discuss a point which is of the first importance to the whole of the colliery district. This was the question of high explosives, namely, carbonite and ammonite, at the Lower Duffryn and George Pits collieries. The conviction of the meeting was, that as Mr. McNab had introduced ordinary gunpowder, in a form which was perfectly harmless, and would not ignite coal dust, the use of the high explosives was not required, and in the opinion of the meeting—formulated into a resolution—a protest was justified against the Government for introducing a measure to prevent the use of gunpowder in collieries. The meeting in question represented the Aberdare and Merthyr Colliers' Association, but the opinion against high explosives will very likely be echoed by the general body.

The coal returns for January are satisfactory, and show an increase from Cardiff, Swansea, Newport, and Llanelly collectively of 117,850 tons, as compared with the corresponding month of last year. Cardiff total was:—Foreign, 936,414 tons; coastwise, 158,430 tons. Newport:—Foreign, 172,481 tons; coastwise, 76,031 tons. Swansea:—Foreign, 76,905 tons; coastwise, 50,203 Llanelly:—Foreign, 12,067 tons; coastwise, 5690. With regard to the other industries, Cardiff nearly monopolises the whole of iron and steel by despatching 1631 tons, to 52 tons from Newport, and 24 tons from Swansea. So in other exports Cardiff sent away 9834 tons of coke, to 743 tons from Newport, and 862 tons from Swansea; and 21,601 tons patent fuel, to 2475 tons from Newport, Mon., and 12,314 tons from Swansea. Doubtless, as the spring advances, there will not be so marked a difference in some of the shipments. The severe frost and generally bad weather of late has told heavily on coal shipments. The Cardiff total last week was scarcely 250,000 tons, Swansea 22,890, and the average was not maintained at Newport. Fully half of Swansea total went to France, and the United States took 2145 tons anthracite.

The tendency of the coal market at Cardiff at the beginning of the week was upwards, but by mid-week prices fell about 3d. per ton, and remain rather dull. The latest quotations show this:—Best steam coal, 10s. 3d. to 10s. 6d.; seconds, 10s. to 10s. 3d.; dry, 9s. 6d. to 9s. 9d.; first-class Monmouthshire, 9s. to 9s. 6d.; second, 8s. 9d. to 9s. 3d.; best small, 4s. 6d. to 4s. 9d.; second, 4s. to 4s. 3d. House-coal shows an increasing demand, and slightly better prices, in some cases a distinct advance of 3d. Best is quoted at 10s. 9d. to 11s.; No. 3 Rhondda, 10s. 3d. to 10s. 6d.; small, 6s. 3d. to 6s. 6d.; No. 2 Rhondda, 8s. 9d. to 9s.; small, 4s. to 4s. 3d.

Coke is not quoted firmly, and inferior furnace is now offered as low as 11s. 9d. to 12s.; best, 13s. 6d. to 14s. 6d.; foundry, 15s. to 16s.; special foundry, 22s. to 23s.

Patent fuel is improving in demand and price, and 3d. per ton advance is noted. Best brands realise 10s. 6d. to 10s. 9d.; inferior, 10s. to 10s. 3d. Pitwood stocks remain full, and prices are in consequence rather weak. Good timber is quoted at 14s. to 14s. 3d. With regard to this trade it may be noted that the tendency is upwards, as little tonnage has come in on account of the weather, and anything like a good demand clearing stocks will send prices up. Local agitation is getting on again in the direction of substituting steel for timber in colliery beams and pit props, and it is maintained that if colliery owners will only face the initial outlay, they will soon find steel more economical than wood. One assertion made by an authority of standing in Glamorgan is that foreign wood coming to the coal ports is deteriorated by submersion for a long time in the water, thus losing its preservative qualities, turpentine, &c. It would be well for the trade to take up the question, and investigate in their own interests.

I regret having still no improvement to record in iron and steel. The leading steel works continue to import ore largely from Bilbao, Blaenavon having three large cargoes this week. Stagnation seems increasing in most branches, and in neither is there any degree of briskness. A small make of merchant iron, small goods, and a moderate average of steel bars for tin-plate works, constituted pretty well all that is doing, and I see that, unmindful of the distress existing, more or less marked in all the Welsh industries, there is an intention on the part of one section of the ironworkers, the mechanics, to end the sliding scale.

Iron and steel quotations are practically the same as last week. Glasgow pig is slightly firmer. Heavy rails remain at £3 15s. to £3 17s. 6d.; light from £4 7s. 6d. Bessemer steel bars are at £3 15s. to £3 17s. 6d. Siemens best from £4. On 'Change, Swansea, it was stated that the decrease in the make of tin-plates had averted a further fall, so prices remain at their late figures. Bessemer cokes from 9s. 6d., and Siemens from 9s. 9d.; ternes, 18s. 9d. to 22s. 6d.; and best charcoal 10s. 9d. to 12s. 6d. according to brand. Swansea anthracite from 8s. 9d. to 12s. 6d.

The Swansea Harbour Trustees have furnished the following official return for last week of tin-plates received from the works, shipped, and in stock:—Received, 87,714 boxes; shipped, 87,006 boxes; leaving in stock 234,842 boxes. It will be noticed that make and shipments are closely approaching each other, and in the opinion of competent judges of the situation, this, brought about by the laying by of many of the mills for a time, will have a tendency to mend matters. But what is wanted even now is a larger reduction in wages. On 'Change this week it was firmly stated that the only remedy is the further stoppage of mills. At Briton Ferry eighteen mills worked last week. In this quarter the weather has told severely on the extension of the Briton Ferry Works, and labourers have suffered.

The disposal of the relief funds in connection with the Cilfynydd disaster, yet unappropriated, and which amount to over £16,000, was the subject of an important meeting at Cardiff this week. The meeting was composed of miners' leaders, and the decision at the close was to submit the whole question at issue with the permanent society to the arbitration of the ex-mayors of London, Cardiff, and Newport, Monmouthshire.

At the Welsh House Fuel Company's Works, Newport, on Tuesday, a boiler 2-ton weight, was blown over 200 yards, and two men and a boy were seriously injured. The effect of the weather is acute on all pipes and machinery. At the port the hydraulics are constantly affected, to the great hindrance in loading coal.

Distress is great at Cardiff, Swansea, and Newport, and more or less throughout the district on account of the hindrance to nearly all outdoor employment, building, labour at the docks, and at the surface at the collieries. This is prompting the humane, and as usual, the Marquis of Bute and Sir W. T. Lewis are open-handed, and good work is being done by all the local authorities.

A fatal accident in sinking is reported from Abertillery, by the upset of the "bouk," four men being killed.

Ship repairing at Cardiff is becoming notable. The steamer Rotherfield, 4500 tons, was placed this week on the Windsor slipway now acquired by Mordey, Carney and Co. This is the largest yet grappled with.

I much regret to place on record the death of Mr. T. Jones, cashier, Dowlais Works. He succeeded Mr. Maynard Harrison, who is still represented in some of the North of England works, and was in all respects a Dowlais man, the contemporary of Edward Williams, Middlesbrough, and of W. Jenkins, Consett. He died very suddenly, Sunday evening, from cardiac syncope.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Staff engineers: D. Griffin, to the Scylla; G. B. Alton, to the Talbot; F. A. Cocks, to the Devastation. Engineer: A. J. Carnt. Assistant-engineer: T. J. Morgan, to the Scylla.

LIVERPOOL ENGINEERING SOCIETY.—The usual fortnightly meeting of this Society was held at the Royal Institution, Colquitt-street, on Wednesday evening, February 6th—Professor H. S. Hele Shaw, M. Inst. C.E., president in the chair—when a paper was read by Mr. Henry H. West, M. Inst. C.E., M. Inst. N.A., entitled "The Principles of Statical Stability in Ships." The discussion upon the paper was adjourned to the meeting on February 20th.

ENGLISH ENGINES IN CHINA.—The first of a set of three new pumps recently forwarded by Messrs. Hathorn, Davey and Co., Leeds, to the Chinese Engineering and Mining Company's works at Tongshan was started on Monday morning, December 3rd, at their No. 2 shaft. A select company was invited to witness the turning on the steam. Amongst those present were, the company's secretary, Mr. Tong Kai-sun, Messrs. Lo Tao-sing, resident administrator, and W. Wan, mining engineer. The foreigners present were:—Messrs. G. Short, colliery engineer; J. Hoare and G. Martyn, reviewers of works; E. Binks, W. Guy, and A. H. Mackay, of the mining company. All being ready, the signal to start was given; and the manufacturer's representative and erector, Mr. R. Buckle, turned on the steam. At the first stroke of the engine a large quantity of Chinese crackers and fireworks were ignited with good effect. Cake and wine were afterwards served to the company, and "success to the new pump" was proposed by Mr. Tong Kai-sun, and enthusiastically drunk by the company. The new pump so successfully started is one of the latest type of Hathorn, Davey and Co.'s well-known differential pumping engines, with a double-acting ram of 11in. diameter and 4ft. stroke; it throws 475 gallons of water per minute from the bottom of the No. 2 shaft to the surface, a distance of 300ft. The engines referred to consist of three compound surface condensing differential underground pumping engines, having cylinders 18in. by 30in. in diameter by 4ft. stroke. Each capable of raising 475 gallons per minute 300ft. vertically.

LEEDS ASSOCIATION OF ENGINEERS.—At the monthly meeting of this Association on Thursday, January 31st, the President, Mr. S. Thornton, in the chair, Mr. James Bowers read a paper on "Balanced Slide Valves and Piston Packings." He said that in the years 1890 to 1892 upwards of twenty patents were taken out for balancing slide valves. The objection to these was the number of loose working parts, which, being covered up in the steam chest, could not be seen, nor was any provision made to ascertain that they were acting. He then described an arrangement, simple and efficient, consisting of an ordinary slide valve planed, on the bank of which was bedded a plate with a piston cast on it, fitting in a cylinder cast on the steam chest cover. Bolted in this cylinder was a copper diaphragm, slightly elastic, to which the upper end of the piston was attached. The difference in area between all the surfaces acted upon by the steam in either direction was just sufficient to keep the valve to its face, and Mr. Bowers explained the method of calculating the required area. In reference to piston packings, he also drew attention to a special form. The piston and packing rings constituted a solid block, the rings following up any wear in the cylinder and doing all the work. Two rigid rings were forced apart laterally on the piston body by a series of spiral springs, and, being turned on the rim to an angle of about 75 deg., they wedged two external elastic rings into close contact with the sides of their recess and the wall of the cylinder. The pressure all round being equal, the cylinder could not wear oval, and when used in piston valves the rings could not be compressed when passing the steam ports. The paper was illustrated by diagrams and specimens of machinery. An animated discussion followed, in which Messrs. H. McLaren, Towler, Wood, Benton, Welbury, Dickenson, Blackburn, Thornton, Drake, Lupton, and Tempest took part, some of the speakers favouring other methods of balancing and packing.

AMERICAN NOTES.

(From our own Correspondent.)

New York, February 6th.

Until the apprehensions of another panic or depression are removed, no improvement can be reasonably expected. At this writing an animated debate is in progress over the wisest policy the Government should pursue. The masses of the people denounce the policy which compels such a Government to borrow money. Its entire policy will be reversed under coming Republican rule, though tariff duties will be kept at the lowest safe limit. General business is improving slightly. All manufacturing and transporting companies will be buyers of equipments, supplies and material. The volume of business will be decidedly larger for the coming spring than last. A temporary dulness has overcome the iron trade. Pig iron is quiet and weak. Billets firmer; steel rails steady at twenty-two dollars at mill. Girder rails twenty-four dollars. Nail makers are increasing production again. The prospects are favourable for a quiet, steady expansion of demand for almost all material. It is possible that a settlement of the Government financial policy would so strengthen confidence in railroad circles as to lead to the purchase of a large volume of equipments and rolling stock, which are badly wanted.

LAUNCHES AND TRIAL TRIPS.

Messrs. Edward Finch and Co. launched at Chepstow on the 12th inst., the tug Mindello, built to the order of the St. Vincent Cape Verde Island's Coaling Company. Her dimensions are 55ft. by 12ft. 6in. by 7ft. 8in., and she will be fitted with engines 11in. and 22in. by 15in. stroke, and boilers 7ft. 6in. by 8ft. 6in. long.

On 8th inst. the launch took place from the building yard of Messrs. Napier, Shanks and Bell, at Yoker, of the steel screw steamer Shengking, built for Messrs. John Swire and Sons, London, and intended for their Chinese coasting trade. She is 260ft. by 38ft., with a shade deck and deckhouses for the accommodation of a large number of passengers. The engines, to be supplied by Messrs. David Rowan and Son, are of the most improved type, and the vessel will be completed with steam cranes, winches, &c., of the most complete description. The owners were represented at the launch by Mr. J. H. Scott, and the vessel was named by Miss Shanks, of Belgrade Villa, Pollokshields. The Shengking is the eleventh vessel built by Napier, Shanks and Bell for service in China and Japan.

On Saturday last the s.s. Isle of Kent, which has been built by Messrs. Ropner and Son, Stockton-on-Tees, to the order of Messrs. Dixon, Robson, and Co., of Newcastle-on-Tyne, was taken to sea for the trial of her machinery and adjustment of compasses. The steamer is of the following dimensions, viz.:—Length between perpendiculars, 315ft.; breadth, 40ft. 6in.; depth moulded, 23ft. 7in., and has received the highest class at Lloyd's. She has a half-poop, raised quarter deck, and a partial awning deck extending continuously from abaft the engine-room to the bow, with chart and wheel-house amidships, and also a large iron house containing commodious quarters for the engineers. The saloon and cabins for captain and officers are in the poop aft, while the crew and firemen are berthed in the forecastle forward. Her triple-expansion engines are by Messrs. Blair and Co., having cylinders 22½in., 37in., and 61in. diameter, with a piston stroke of 42in., which are supplied with steam from two large steel boilers having a working pressure of 160 lb. The hull and machinery have been built under the supervision of Mr. Dykes, the owner's superintendent, who was present.

On Friday, the 8th February, Messrs. Wm. Simons and Co. launched complete, with steam up and ready for work, a steamer for carrying sewage sludge. It is built to the order of the Salford Corporation, under the direction of Mr. J. Corbett, their engineer, and is capable of carrying 600 tons of *débris*. It will receive its load at the Sewage Works below Salford, and convey it outside the Mersey into the open, a distance of fifty to sixty miles. The vessel is very strongly constructed, the hull, boilers and machinery being to Lloyd's 100A Class, and will have a speed loaded of ten knots per hour. The hull is constructed of steel, divided into ten water-tight compartments, and has a raised deck forecastle. Accommodation is provided for the officers amidships. The engines—two sets—are of the triple expansion type, driving twin propellers, and steam is provided by two steel boilers of 160 lb. working pressure. The hopper is formed of four tanks, each of 150 tons capacity, for the reception of the sewage; they can be filled separately or simultaneously as required, and can be discharged by a distributing arrangement fixed on deck. The vessel is named the Salford.

On Monday, the 11th inst., Messrs. Irvine and Co., West Hartlepool, launched a fine steel screw steamer of about 3500 tons deadweight carrying capacity, built to the order of Messrs. Jackson Brothers and Cory, London. The vessel will take Lloyd's highest class, and has been built under special survey. Her dimensions are 290ft. by 39ft. by 21ft. 8in. The deck erections consist of half poop, raised quarter-deck, long bridge, and topgallant forecastle. The saloon and cabins for captain and officers are fitted up in the poop. The engineers are berthed under bridge deck at after end of engine-room, and the crew in topgallant forecastle. The hull is built on the web frame principle, with double bottom for water ballast fore and aft. Large hatchways are fitted, four steam winches by Irvine and Co., steam steering gear amidships, screw gear aft, large donkey boiler, and direct steam windlass. The boats are placed on beams overhead, and all modern appliances will be fitted for general trading. Engines of the triple-expansion type are being supplied by Messrs. Thos. Richardson and Sons, Hartlepool. The hull and machinery have been built under the supervision of the owners' superintendent, Mr. William Dumlin. The vessel was named Ibex by Miss Rosie Jackson. This is the third vessel built by Messrs. Irvine and Co. for this firm.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

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

30th January, 1895.

2095. Circular Knitting Machines, J. Higham, Manchester.
2096. Reducing Friction in Sluice Valves, T. Blakeborough, Brighouse.
2097. Safety Valves, R. Cockburn, Glasgow.
2098. Casting Long Lengths of Metal, W. J. Warren, Leeds.
2099. Pendants for Gas Lamps, &c., W. Beal, Birmingham.
2100. Cables for Electrical Distribution, G. Schultz, Liverpool.
2101. Absorbent Towels or Pads, R. Ecroyd, London.
2102. Starting and Stopping Apparatus, J. Dulait, Liverpool.
2103. Mechanical Cooking Pot, J. V. Moore, London.
2104. Reaping and Mowing Machines, J. Picken, Glasgow.
2105. Safety Stirrup, H. Fraser and A. McHardy, Glasgow.
2106. Music Typewriting Machine, G. T. Plunkett, Dublin.
2107. Table Cutlery, P. T. Smith and W. Tyzack, Sheffield.
2108. Sockets of Miners' Picks, F. Willoughby, Sheffield.
2109. Axes, J. Wall, Sheffield.
2110. Ferrules for Umbrellas, &c., E. F. Wickham, London.
2111. Rotary Blowers or Pumps, T. W. Green, London.
2112. Oil Lamps, R. Wilson, London.
2113. Guide Bracket for Door-rod, F. Banks, London.
2114. Extracting Gold from Ore, A. de C. Scott, London.
2115. Method of Binding Documents, G. W. Mallet, Brighton.
2116. Protecting Trouser Bottoms, A. H. C. Burrow, London.
2117. New Cigar Cutter and Lighter, F. Schultz, London.
2118. Viewing Stereoscopic Pictures, E. de Pass.—(*P. Moëssard, France*)
2119. Securing Shirt, &c., Studs, J. D. Jones, London.
2120. Spectacle Case, E. A. Darling, London.
2121. Foothold Galoches, J. F. O'Brien, London.
2122. Sewing Machines, F. W. Kitto, London.
2123. Safety Appliances for Tramcars, H. H. Stölting, London.
2124. Portable Houses, P. Cave, London.
2125. Brushes, P. R. J. Willis.—(*C. W. Roche, Canada.*)
2126. Water-closet Pans or Basins, T. Salter, London.
2127. Burners for Lamps, W. Morgans, London.
2128. Elevating Apparatus, G. G. Hunt, London.
2129. Machine Guns, G. V. Fosbery, London.
2130. Wrenches, A. J. Boult.—(*The Mossberg Wrench Company, United States.*)
2131. Mechanism for Typewriters, G. Salter and J. S. Foley, London.
2132. Adjusting the Seats of Carts, F. Woodhead, London.
2133. Electric Batteries, J. Pogneaux, London.
2134. Electric Signalling Apparatus, A. B. y Baqué, London.
2135. Apparatus for Refrigerating, A. J. Adamson, London.
2136. Arbor Press, J. H. Sheridan, J. H. Dale, and P. H. Farrell, London.
2137. Printing Telegraph, C. A. Beck and C. Rock, London.
2138. Transferring Goods on Railways, R. H. Livesey, London.
2139. Looms for Weaving Ribbons, J. Reixach, London.
2140. Explosion Engines, T. Gilbert-Russell, London.
2141. Dentist Clamps, R. Richter, Berlin.
2142. Printing Machines, W. S., J. K., and W. W. Foord, London.
2143. Pneumatic Tire Air Valves, J. M. Dumstrey, London.
2144. Cycles, C. Paulitschky, London.
2145. Manufacturing Shaded Fabrics, J. Dietsch, London.
2146. Fly Catchers, F. Tunbridge, London.
2147. Rings for Holding, &c., Curtains, W. Woolf, London.

31st January, 1895.

2148. Weight Gearing for Bicycles, A. J. T. Chinner, London.
2149. Cigar Manufacture, M. Dussel, Baden, Germany.
2150. Cycle Brace Attachment, H. Rogers and T. S. Shevling, Birmingham.
2151. Incandescent Gas Light Mantles, T. Andrew, London.
2152. Certain Woven Fabrics, G. and F. Priestley, Bradford.
2153. Hydraulic or Fluid Pressure Motors, S. H. Wright, Liverpool.
2154 Registering Tap, M. Ballinger and W. Baynton, London.
2155. Rubber Toilet Washers, W. H. Chase, jun., London.
2156. Adjustable Steam or Vapour Bath, T. R. Curtis, Bristol.
2157. Holding Blind or other Cords, E. R. Wethered, Woolwich.
2158. Method of Printing on Bisque Pottery, T. Holt, Stoke-on-Trent
2159. Supporting Blackboards on Easels, W. Woolard, Herts.
2160. Funnel Stopper, J. Rixen and W. Baynton, London.
2161. Gentlemen's Reversible Trousers, J. Carse, Northumberland.
2162. Casement Fastener, H. Berry, Crediton.
2163. Securing Tires upon Coach Wheels, N. Munro, Glasgow.
2164. Mole Trap, W. Anderson, Glasgow.
2165. Cycle Toe Clip, F. Crabbe and E. M. Parfrey, Swansea.
2166. Slide Rules, N. Pickworth, Manchester.
2167. Button Show Cards, T. Morton, Birmingham.
2168. Looms, E. Hindle, G. Hindle, and E. Lees, Halifax.
2169. Apparatus for Tilting Casks, E. Edwards, Birmingham.
2170. Bracket Pin Protector, J. B. Hardisty, Sandiacre.
2171. Mechanical Power, W. Burns and J. and J. A. McLay, London.
2172. Locks, H. D. Fitzpatrick, Glasgow.
2173. Cycle Construction, T. F. Walsh, Dublin.
2174. Bolt End Cutting Tool, J. Brierley, Middlesbrough.
2175. Decorating Ceramic Ware, A. Sherwin and C. W. Cobden, Longport.
2176. Floral Decoration of Pottery, W. Wade, Burslem.
2177. Steam Generators, W. Hök and C. Elliott, Sunderland.
2178. Coats and Similar Garments, J. M. Thompson, Manchester.
2179. Fitting and Cutting Coats, J. M. Thompson, Manchester.
2180. Carburetting Gas, W. Ewing and J. Meikle, Glasgow.
2181. Taps for Casks, E. B. Openshaw, Manchester.
2182. Electric Lamp, G. F. Attree, Brighton.
2183. Umbrella Sticks, L. Sandberg, Berlin.
2184. Picture Frame Mouldings, G. W. Butt, Littlehampton.
2185. Folding Chairs, H Schlesinger, Berlin.
2186. Bicycle and other Spanners, C. L. Parkin, Sheffield.
2187. Safety Bedstead Guard, F. Jordan, London.
2188. Distilling and Gasifying Oils, R. V. Horsfall, Manchester.
2189. Billiard Tables, A. and H. Normanton, Manchester.
2190. Knitting Machines, W. and C. W. Harrison, Manchester.
2191. Sulphate of Ammonia Saturator, P. Duggan, Rosherville.
2192. Holding Bobbins, P. Smith and S. Ambler, London.
2193. Bottle Stoppering, R. J. Urquhart.—(*M. Loewe, Germany.*)
2194. Cycle Tire Valves, J. C. Hall and W. G. Hall, London.
2195. Ether Saturator for Limelight, W. Houldershaw, Liversedge.
2196. Varnish and Solvent for Metals, H. Crowther, London.
2197. Screening and Washing Coal, A. B. Southall, Sheffield.
2198. Box-keys and Spanners, R Downham, London.
2199. Measuring Quantities of Spirits, A. Senior, London.
2200. Sterilised Filters, O. W. Brandenburg and F. H. Pott, London.
2201. Crucibles, J. W. S. Holt, S. Hargreaves, and J. Davies, Liverpool.
2202. Book Rests and Arm Supports, T. G. Harig, Manchester.
2203. Carbon, O. W. Brandenburg and F. H. Pott, London.
2204. Sleeve Expanders, F. P. Wright, Liverpool.
2205. Softening and Purifying Water, H. T. Wright, London.
2206. Economising Boiler Fuel, E. M. Mallett, London.
2207. Regulator for Gas Cooking Stoves, D. W. Petrie, London.
2208. Cycle Pedals, C. Byrne, London.
2209. Supply of Water to Closets, &c., A. Long, London.
2210. Wire Holder for Brushes, C. E. Billing, London.
2211. Spectacular Shows, I. Kiralfy, London.
2212. Feather Broom, H. H. Lake.—(*J. Stuttgardter, Germany.*)
2213. Producing Oxygen, J. C. Richardson, London.
2214. Manipulating Lead Pipes, W. Barns, jun., London.
2215. Screwing Machines, C. Jahn, London.
2216. Attachment for Price Tickets, F. G. Sage, London.
2217. Hair Fasteners, G. and H. Lichtenfeld, London.
2218. Alternating Currents of Electricity, G. Hummel, London.
2219. Police Lanterns, W. Wright, London.
2220. Holder for Bottles, W. H. Jones, London.
2221. Oilskins, J. Petersen, London.
2222. Cradles, G. H. Webb and A. M. Walker, London.
2223. Phonographs, G. McMurdie and C. Daggett, London.
2224. Appliances for Incandescence Gas Lights, J. Moeller, London.
2225. Facilitating the Drawing of Objects in Space, J. V. Gane, London.
2226. Protector for Cycle Shoes, E. and A. Brown, London.
2227. Piers, H. Brockelbank, London.
2228. Operating Electric Motors, W. A. Clatworthy, London.
2229. Leaf-turners, M. Simpson and W. Springett, London.
2230. Cycles, J. Marriott, London.
2231. Cycles, J. Marriott, London.
2232. Indexes, L. D. Williams, London.
2233. Cranks, J. Wilson, London.
2234. Manufacture of Elastic Fabrics, E. Deitz, London.
2235. Automatic Liquid Supply, A. V. Tims, London.
2236. Turning the Leaves of Music, W. S. Simpson, London.
2237. Induction Coils, J. F. Bachman, J. Liebscher, and A. Vogt, London.
2238. Street Advertising Novelty, T. Hether and F. T. Easton, Hammersmith.

1st February, 1895.

2239. Bell Handles, J. Parker, Ayrshire.
2240. Hydraulic Motor, J. Overton, Coventry.
2241. Regulator-charge Valves, W. J. Craig, jun., London.
2242. Picking Straps for Looms, W. White, Bradford.
2243. Mounting Safety Valve Levers, G. Marchant, Bradford.
2244. Sewer Ventilators, W. Wall, London.
2245. Securing Cigars and Cigarettes, P. A. Abrahamson, London.
2246. Filling Bottles with Liquids, G. A. Swindley, Swinton.
2247. Spindles, B. A. Dobson and J. Turpie, Manchester.
2248. Miners' Safety Lamps, J. H. Rothwell, Manchester.
2249. Spraying or Diffusing Liquids, R. B. Walker, Dundee.
2250. Triple Pole Switches, F. H. Starling, Nottingham.
2251. Velocipedes, A. E. Dinsmore, Liverpool.
2252. Rubber Condensers, T. G. Beaumont, Halifax.
2253. Adjustable Soldering Cramp, J. F. Whiteside, Clitheroe.
2254. Golf Balls, J. H. Exley, Bradford.
2255. Rims for Holding Cycle Tires, H. Cooper, Bristol.
2256. Threading Needles, J. Barlow, Nottingham.
2257. Stoppering Bottles, J. A. King, Dublin.
2258. Fog Signal, H. N. Baxter, Northallerton.
2259. Non-conducting Sad-iron Stand, W. R. Hatton, London.
2260. Orange Peeler, W. Swarbrick, Fleetwood.
2261. Sanitation of Yachts and Vessels, H. Ward, Glasgow.
2262. Device for the Use of Smokers, &c., J. Potts, Derby.
2263. Match Lighter, A. F. Genlain, Weston-super-Mare.
2264. Malting of Grain, E. Larsen.—(*The Berliner Actiengesellschaft für Eisengiesserei und Maschinenfabrik vormals J. C. Freund and Co., Germany.*)
2265. Ventilating of Carriages, W. Williams, Morriston, near Swansea.
2266. Receptacle for Needles, &c., F. Samuel, London.
2267. Valve for Liquids, M. Syer, London.
2268. Windows, S. Bastow, London.
2269. Latches, &c., for Doors, F. H. Gilbody, Manchester.
2270. Pneumatic Tires for Vehicles, J. H. Barry, London.
2271. Preventing Bolts from Slipping, R. H. Courtenay, London.
2272. Combined Scale and Pencil, A. D. Watson, London.
2273. Files for Letters, F. Müller, London.
2274. Burners or Lamps, W. Darby and I. Darby, London.
2275. Apparatus for Heating Water, W. Darby and I. Darby, London.
2276. Applying Fluids to Surfaces, F. Tingle, London.
2277. Connecting Electrical Accumulator Plates, G. Hirschmann, London.
2278. Process for Production of Metals, W. Kaufmann, London.
2279. Pneumatic Tires, H. and I. Wood, Ottawa.
2280. Galvanometers, W. O. Smith and G. K. B. Elphinstone, London.
2281. Golf Scorer, G. Willoughby, London.
2282. Railway Signalling, W. S. and C. R. Boult, London.
2283. Tiling Roofs, O. A. Ellis, A. B. Partridge, and F. Shenton, London.
2284. Adjustments for Mattresses, C. L. Fielder Kingston-on-Thames.
2285. Railway-switch Frogs, R. T. Waldrep London.
2286. Holding Leaves of Books, E. L. Brown, London.
2287. Kilns for Baking Earthenware, W. T. Griffin, J. Lewis, and G. H. Llewellyn, London.
2288. Voltaic Batteries, D. G. Fitzgerald, London.
2289. Recording Conversations, J. E. Kingsbury.—(*The Western Electric Company, United States.*)
2290. Bottle-washing Apparatus, W. Carter, London.
2291. Attachment for Clinical Forceps, D. M. Gill, London.
2292. Velocipedes, E. R. Short.—(*Möldner and Skreta, Germany.*)
2293. Air Compressing Machines, C. T. A. Hanssen, London.
2294. Separating Lubricants from Water, O. I. Simonsson, London.
2295. Bedsteads, E. Edwards.—(*A. C. Haunstrup, Denmark.*)
2296. Stoppers for Bottles, W. B. and A. Bishop, London.
2297. Vent Pegs, A. A. King, London.
2298. Securing Handle-bars of Velocipedes, C. J. Hill, London.
2299. Stop-cock, J. Catterall, London.
2300. Closet Seats, T. J. Shaw, London.
2301. Domestic Ranges or Ovens, W. Whittle, London.
2302. Locking Nuts on Bolts, B. H. Courtenay, London.
2303. Lighting, &c., Electric Lamps, L. Hermand, London.
2304. Sorting Particles of Material, L. Piette, London.
2305. Photochromoscopes, F. E. Ives, London.
2306. Fork Guards, J. J. P. A. Goggin, London.
2307. Heating Water for Boilers, W. and W. A. Clark, London.

2nd February, 1895.

2308. Testing Metallic Quality in Iron, J. A. Ewing, Cambridge.
2309. Filters for Water, &c., E. J. Duff, Manchester.
2310. Cover for Lubricating Holes, R. H. Cohn, Gosforth.
2311. Waterproof Shaving-pad, J. H. Nunn, London.
2312. Regulating Electrical Pressure, J. T. Niblett, London.
2313. Manufacturing Monoxide of Aluminium, W. Mills, London.
2314. Garden Rakes, J. Parker, Keighley.
2315. Boots, W. J. Gale, H. O. Collier, C. Harris, and F. J. Brown, Bristol.
2316. Combined Hollow Pipe Plug, H. Davies and R. S. G. Lewis, Sunderland.
2317. Securing Tool Bags to Cycles, D. A. Martin, Birmingham.
2318. Signalling the Speed of Engines, J. T. Dawes, Liverpool.
2319. Pipe Covers, E. Brown and S. Brown, Birmingham.
2320. Wind Motor, J. Griffiths, Wrexham.
2321. Parlour Game, H. O. Roberts and J. O. Roberts, Gloucester.
2322. Lettered Index-books, J. R. Bell, Newcastle-on-Tyne.
2323. Making Paving Slabs, C. and A. Musker, Liverpool.
2324. Tell-tales for Engines, Walkers Engine Speed Indicator and Recorder Company, and J. K. Adelsberg, Liverpool.
2325. Jerseys, &c., A. Scott, London.
2326. Horseshoes, A. E. G. Way, Bristol.
2327. Oil Motor Valve Motion, T. A. W. Clarke, Leicester.
2328. Pneumatic Roller Skates, F. I. Gibbs and W. Wright, Birmingham.
2329. Screw-propellers, T. Smith and Sons and T. Smith, Birmingham.
2330. Water-marking Paper, H. G. Forbes and E. M. Sommerville, Bitton, near Bristol.
2331. Lubricating Steam Engines, J. A. Frerichs, jun., Erith.
2332. Extinguishing Fires, J. W. Radford and T. W. Marsters, Nottingham.
2333. Using Electric Light, A. G. Adamson, Glasgow.
2334. Spindles for Braid-plaiting Machines, J. Booth, Manchester.
2335. Placing Pipes in Sticks, H. Windmüller, Berlin.
2336. Safety Bit, A. J. Howell, Hawes, R.S.O., Yorks.
2337. Last Support, M. O'Fallen and J. P. Tolton, West Bridgewater, Mass.
2338. Rheumatic Cure, R. Richardson, Barrow-in-Furness.
2339. Obtaining Motion, J. Harris and J. Reah, London.
2340. Fabric for Making Tires, J. W. Smallman, London.
2341. Driving Electrical Machines, W. H. Hallsworth, Dukinfield.
2342. Nut and Screw Driver, F. H. C. Harper, London.
2343. Electric Lamps, A. E. Pope.—(*F. R. Pope, Holland.*)
2344. Trousers' Stretcher, S. Brown and J. T. Lancaster, London.
2345. Lamps, A. W. Martin, Manchester.
2346. Temples for Looms, W. Simpson and the Duplex Weaving Appliance Co., Ld., Manchester.
2347. Gas or other Rotary Engines, W. Greifenberg, London.
2348. Signalling, R. Muschamp, London.
2349. Saddles for Cycles, and Mats, A. E. Wale, Birmingham.
2350. Stop Mechanism for Drums, &c., V. Bergmann, Birmingham.
2351. Vote Recording Apparatus, W. Lake, London.
2352. Mechanical Stokers, T. Forknall, London.
2353. Armillary Spheres, S. M. Gibbs, London.
2354. Door or Portiere Rods, &c., T. G. Jeffery, London.
2355. Testing Apparatus, W. E. Ayrton and T. Mather, London.
2356. Fittings for Music Stands, T. J. Hammersley, London.
2357. Spoon for Infants and Invalids, E. Auerbach, London.
2358 Kilns for Earthenware Pipes, &c., J. Hall, London.
2359. Radiator Grate, B. H. H. Klene, London.
2360. Signs, Incised Facias, and Tablets, C. F. Cave, London.
2361. Revolving Cabinet Floor Lamps, A. Kelvie, London.
2362. Wire Cloth Kiln Bedding for Oats, J. Smith, Glasgow.
2363. Photographic Printing Frames, A. H. Petit, London.
2364. Bleaching Powder, E. Fidler, Liverpool.
2365. Architects' Set-squares, F. R. Lawson, Fenton.
2366 Electro-dynamometers, Siemens Bros. and Co. and E. F. H. H. Lauckert, London.
2367. Pulley Carriers for Wire Pulls, C. Hodgson, London.
2368. Engraving Machines, F. Wright. London.

2369. ORANGE CAKE, G. Fietta, London.
2370. PREVENTING VESSELS CAPSIZING, H. A. W. Middleditch.
2371. TOY GAMES, R. W. Barker.—(*G. L. Brower, United States.*)
2372. MALTING GRAIN, J. W. Free, London.
2373. SOCKET JOINTS, Bullers, Ld., and E. J. Chambers, London.
2374. TANK and APPARATUS for LIQUIDS, T. P. Marsh, London.
2375. FIRING MECHANISM, T. W. and A. H. Watson, London.
2376. PRINTING MACHINES, T. R. Johnston, London.
2377. SHARPENING and POINTING PENCILS, C. Hampton, London.
2378. TIME-TABLE, L. M. D'Orsey, London.
2379. WATERPROOF GARMENTS, A. Lee, London.
2380. LAMP-HEATED WATER VESSELS, H. B. Tatham, jun., London.
2381. TYPE-WRITING MACHINES, R. Hertzberg, London.
2382. MACHINE GUNS and CARTRIDGES, F. M. Garland, London.
2383. INDICATING POSITION of SUNKEN SHIPS, T. Burbidge.
2384. HORSESHOE BENDING MACHINES, S. G. B. Cook, London.
2385. BLOCK ICE, H. V. Weyde, London.
2386. CONCENTRATING ORES, A. M. Clarke.—(*W. J. Hammond, United States, and J. Gordon, Brazil.*)
2387. DIAZO DYE-STUFFS, A. M. Clark.—(*P. Becker, Russia.*)

4th February, 1895.

2388. APPARATUS for DOLLYING CLOTHES, J. Wilson, Preston.
2389. HYDRO-PNEUMATIC MOTOR, C. J. Eyre, London.
2390. ADJUSTABLE MOUSTACHE LIP, F. Holland, Llandudno.
2391. PNEUMATIC CRUTCH, R. A. Ward, Kettering.
2392. ARC LAMPS, F. W. Branson, Leeds.
2393. ANCHOR, W. B. Powell, London.
2394. PRIMARY BATTERIES, H. and E. M. Levetus, and W. Rowbotham, Birmingham.
2395. HANDLE for CYCLES, W. H. Wallis, Southampton.
2396. POWER LOOM DOBBIES, W. G. Simpson, Galashiels.
2397. MINERAL WATER BOTTLE OPENER, R. H. C. Cotton, Birmingham.
2398. HANDLE FASTENINGS, J. Gaskell and W. Foulkes, Liverpool.
2399. SKETCHING or DRAWING EASEL, J. S. Burgess, Salford.
2400. DECORATING METALLIC BEDSTEADS, C. Meason, Birmingham.
2401. PNEUMATIC TIRES, F. Westwood and W. H. Paull, London.
2402. WOVEN FABRICS, F. Westwood and W. H. Paull, London.
2403. SWIVEL COUPLING WATER TOWER, E. Westbrook, Tunbridge Wells.
2404. BOOT SOCK, S. Dawes and R. R. Jardine, Birmingham.
2405. ROUGHING HORSES' SHOES, J. Ford, jun., Plymouth.
2406. CARRIERS for SIGNAL CORDS, A. K. Evans, Dungannon.
2407. STEAM RELIEVER for KETTLES, &c., G. Gray, Sheffield.
2408. ROLLERS, F. H. P. P. Oram and E. Dothie, London.
2409. SLEDGES, W. E. Turner and W. Wrathall, Keighley.
2410. OPENING CONDENSED MILK TINS, W. Dornan, Hull.
2411. PNEUMATIC HORSE COLLAR, G. T. Plunkett, Dublin.
2412. POST CARDS and LETTER CARDS, H. B. Le Mesurier, Southsea.
2413. A SAFETY STIRRUP HOLDER, G. Bird, Hook, Surrey.
2414. CAPS, F. W. Thompson, Manchester.
2415. CONVERTIBLE SEATS and BOXES, F. H. Ayres, London.
2416. DEFLECTING HEAT into APARTMENTS, G. Milner, London.
2417. HORSESHOE PROTECTOR, J. Bennett and J. Mincher, London.
2418. CLEANING and POLISHING KNIVES, S. Rideal, Manchester.
2419. OPERATING RAILWAY SWITCHES, J. Saxby, London.
2420. WALKING-STICK DISTANCE MEASURER, J. Blacker, London.
2421. ATTACHING PULLEYS to SHAFTING, W. Musselwhite and H. Simpkins, Bournemouth.
2422. HYDRAULIC LIFTING APPARATUS, J. Klein, London.
2423. CALENDARS, J. Harper, Hastings.
2424. DIFFERENTIAL LOW-PRESSURE STILL, A. A. Robin, London.
2425. DRESS FASTENERS, G. H. Gledhill, Halifax.
2426. BALL GRINDING MILLS, A. Herzfeld, London.
2427. MANUFACTURE of ETHERS, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
2428. BATHS, G. F. Butterfield, London.
2429. THAWING FROZEN MEAT, J. D. Postle, London.
2430. INSULATING ELECTRIC CONDUCTORS, G. G. M. Hardingham.—(*The Firm of Felten and Guilleaume, Germany.*)
2431. PROTECTING SORES from INJURY, M. Pitsch, London.
2432. GARMENTS for GYMNASTIC PERFORMANCES, H. Stelling, London.
2433. PNEUMATIC TIRES, J. Jelly, London.
2434. SWEETMEAT, G. Sifo, London.
2435. AUDIBLE REGISTER for CRIBBAGE, &c., C. W. Hayler, London.
2436. FOG-SIGNALLING on RAILWAYS, E. A. B. Bowden, London.
2437. APPARATUS for GENERATING GAS, D. B. Morison, London.
2438. DECANTERS, H. A. Domenget, London.
2439. CATAPLASM, H. H. Lake.—(*A. du Bois-Reymond, Germany.*)
2440. DRYING WASTE VEGETABLE SUBSTANCES, P. Schottländer, London.
2441. COIN - FREED APPARATUS, J. Fotheringham, London.
2442. LADIES' HAT BOX, F. von La Roche, London.
2443. LANDING NETS, W. Baker, G. Raener, and H. G. Smith, London.
2444. PENS, H. Hewitt, London.
2445. RECEPTACLES for DUST SHOOTS, P. J. Jackson, London.
2446. APPARATUS for REFLECTION of LIGHT, J. Boyes, London.
2447. MAKING SOLE LININGS for BOOTS, C. H. Lange, London.
2448. MECHANICAL TOYS, A. Samland and H. von Berlepsch, London.
2449. TANKS for PRECIPITATION of SEWAGE, G. H. Skelsey, London.
2450. BULBS of INCANDESCENT LAMPS, A. L. Fyfe, London.
2451. PROTECTING SHIPS from CORROSION, Sir E. J. Harland, London.
2452. GRADUATING or COOLING APPARATUS, J. Klein, London.

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2453. NON-SLIPPING BOOT HEEL CLIP, Z. J. Francis, Leeds.
2454. COMBINATION DRAWING BOARD, C. W. D. Boxall, Sheffield.
2455. WEIGHING INSTRUMENTS, H. C. Walters, Bury St. Edmunds.
2456. WHIP, T. D. Harries, Aberystwith.
2457. AIR-TIGHT JARS, W. Cooper, Castleford.
2458. PREPARING DISTILLED BEVERAGES, C. W. Ramsay, London.
2459. LOG GAS FIRE, W. E. Graham and F. H. Biddle, London.
2460. HEN-COOPS, H. J. F. Rose, Eaton Bray.
2461. CONSUMPTION of SMOKE in BOILERS, F. Yeadon, Manchester.
2462. WOODEN TUBE for FEEDING BOTTLES, W. Jago, Cornwall.
2463. PROTECTORS for BOOTS, J. Rawson, S. Elson, and J. Jones, Dukinfield.
2464. POINTING RAILS for RAILWAYS, T. Williamson, Wishaw.
2465. INJECTION APPARATUS, R. Finnie and W. Andrew, Campbeltown.
2466. SULPHURIC and NITRIC ACID, W. Garroway, Glasgow.
2467. CLIPS for BUSKS of CORSETS, R. R. Beard, Birmingham.
2468. CHANGE GEAR for BICYCLES, E. Deeley, Birmingham.
2469. TILE for DECORATIVE PURPOSES, T. Wearden, Bradford.
2470. INCANDESCENT FIRE FRAME, W. A. Hughes, Hampton Hill.
2471. WASHING POWDERS, A. Warwick, J. Smith, and P. W. Nicolle, London.
2472. ICE TANKS, J. Siddeley, Liverpool.
2473. SUBMARINE TORPEDO BOAT, H. Carey, London.
2474. DRAWING METALLIC TUBES, J. Hudson, jun., Birmingham.
2475. COFFIN FURNITURE, T. F. Westley, Birmingham.
2476. NEW METAL SMOKING PIPE CASE, L. Weiss, London.
2477. MANUFACTURE of GOLF BALLS, A. W. Stevenson, Manchester.
2478. GOLF CLUB CARRIER, W. Snelgrove and R. F. Goyne, Birmingham.
2479. HORSESHOES, R. Abell, Derby.
2480. GARDEN LABELS, D. Tuley, Hatfield.
2481. MACHINERY for PRINTING TICKETS, S. Jones, Birmingham.
2482. MAKING TEA, W. G. MacIvy and The Princess Company, London.
2483. FURNACE FIREBARS, C. M. Stewart and H. J. Wimshurst, Liverpool.
2484. PARTITIONS for PACKING CASES, P. S. Brown, Glasgow.
2485. UTILISING WASTE HEAT of GASES, J. Patterson, Glasgow.
2486. DUST EXCLUDER for DOORS, &c., P. Treadgold, Redditch.
2487. SMOKE-CONSUMING APPARATUS, A. Gerardin and M. Ringelmann, London.
2488. WASHING BOARDS, A. Drummond and T. Harrison, Glasgow.
2489. BOXES, W. Strain, London.
2490. ATTACHMENT for SECURING HATS, M. Lopez, Manchester.
2491. OBTAINING VALUABLE PRODUCTS, J. R. Lopez, Liverpool.
2492. SUBMARINE TELEGRAPH CABLES, W. S. Seaton, London.
2493. TREATING ORES, J. Y. Johnson.—(*L. Pélatan, France, and F. Clerici, Italy.*)
2494. BICYCLES and other VELOCIPEDES, P. E. Masey, London.
2495. TAPS, F. Moore, London.
2496. CLIP, R. F. Rimmington and J. A. Rimmington, London.
2497. TUBES for ARTESIAN WELLS, F. E. Dieltiens, London.
2498. ROTARY ENGINE, E. W. Hughes and L. Campbell, London.
2499. SAFETY LIFT, E. W. Hughes and L. Campbell, London.
2500. BREAKING-UP the SURFACES of ROADS, H. Morrison, London.
2501. METALLIC BOXES, Jahncke Limited, E. A. Jahncke, and F. A. G. Gmelin, London.
2502. KNITTED FABRICS, S. W. Eden and H. W. Scothon, London.
2503. PLAITING MACHINES, J. H. Walton, London.
2504. COLOURING MATTERS, R. Holliday and Sons and R. Holliday, London.
2505. GUY for SHIPS' DERRICKS, F. G. Cassell.—(*A. W. Abbott, at present upon the High Seas.*)
2506. VELOCIPEDES, C. Harte and S. E. T. Ewing, London.
2507. VELOCIPEDES, A. Devereux and H. Williams, London.
2508. DOG BISCUIT, J. and W. Slow, London.
2509. PHOTOGRAPHIC CAMERAS, H. L. C. Ausbuttel, London.
2510. FASTENING LADIES' SKIRTS, R. Schaefer, London.
2511. WATER-TANKS, C. L. Davis, G. D. Moll, and J. C. Lebret, London.
2512. SCHOOL DESKS, P. H. Taylor and the Scholastic Trading Company, Bristol.
2513. TYPE, J. N. Maskelyne, jun., London.
2514. LASTS, J. Bowler, London.
2515. CHAIN LINKS, R. A. Breul, London.
2516. CODE for SIGNALLING APPARATUS, E. C. Davis, London.
2517. INTERCHANGEABLE MANHOLE COVER, E. H. Whiteford, Plymouth.
2518. PUMPS and ENGINE, A. E. Cutler and R. Donkin, London.
2519. PROVIDING SHIP with WATER BALLAST, H. A. B. Cole, London.
2520. DRYING GOODS and ABSORBING WATER, L. Sinclair, London.
2521. BUTTON PINCERS, &c., Müller and Holzweissig, Leipzig.
2522. CYCLE PEDALS, P. R. J. Willis.—(*L. Gerteis and J. P. Duprat, United States.*)
2523. STERILISED SURGICAL DRESSINGS, S. Immenkamp, London.
2524. WRITING PENS, F. Nevoigt, London.
2525. FLAT-BAR KNITTING MACHINES, C. H. Aldridge, London.
2526. CALENDARS with ROLLING APPARATUS, A. E. Walker, London.
2527. SHEEP SHEARING MACHINES, H. Burgon, London.
2528. CYCLE ROUNDABOUTS, E. I. Brannan, London.
2529. RAILWAY POINTS and SWITCHES, S. Rogozea, London.
2530. WITHERING TEA and other LEAVES, S. Davidson, London.
2531. HEMMERS, H. H. Lake.—(*S. H. Wheeler, United States.*)
2532. MARINERS' COMPASSES, J. A. Hooper, London.
2533. CLAMPS for CROSSED WIRES, A. Levedahl, London.
2534. SORTING BALLS, H. H. Lake.—(*The Cleveland Machine Screw Company, United States.*)
2535. HAND-PIECES for DENTAL BURRS, J. D. Wilkens, London.
2536. CARRIAGE BUFFERS, H. H. Lake.—(*C. A. Gould, United States.*)
2537. RAILWAY BRAKE APPARATUS, A. Kholodkowski, London.
2538. TREATING ORES, G. Robson and S. Crowder, London.
2539. CASTING BOXES for PRODUCING STEREOTYPE PLATES for ROTARY PRINTING MACHINES, A. Sauvée, London.
2540. FLUID SEPARATING APPARATUS, E. J. O'Brien, London.
2541. ELECTRIC BURGLAR ALARMS, L. H. Hordern, London.
2542. STEAM VALVES, J. Casey, London.
2543. CONSTRUCTION of PORT HOLES for SHIPS, J. Casey, London.
2544. CAMERAS, A. J. Boult.—(*A. C. Kemper, United States.*)
2545. FASTENING DEVICES for TRUSSES, K. R. Schramm, London.
2546. PLANING, &c., WOOD, H. Jelley and R. Dorrett, London.
2547. ADVERTISING, R. E. Corsi, London.
2548. CONSTRUCTION of MATCH or VESTA BOX, A. Argles, London.
2549. LINOTYPE MOULDS, E. Girod and W. C. Thomason, London.
2550. GAS ENGINES, C. Crastin, London.
2551. GRINDING the MOUTHS of BOTTLES, W. Bagley, London.
2552. FEED-WATER HEATING APPARATUS, T. C. Palmer, London.
2553. SEPARATING IMPURITIES from WATER in BOILERS, T. C. Palmer, London.
2554. COMPOSING MACHINES, P. M. Justice.—(*The Tachytype Manufacturing Company, United States.*)
2555. METHOD of MAKING WIRED GLASS, E. Walsh, jun., London.
2556. STEAMER COALING APPARATUS, J. B. T. Leportier, London.
2557. CYCLE WHEELS, S. W. Maquay, London.
2558. ELECTRIC ARC LAMPS, O. L. Peard and A. Essinger, London.
2559. ARTIFICIAL STAINED, &c., GLASS, M. E. Norris, Richmond.
2560. DRYING FLOUR, W. L. Wise.—(*G. Stucky, Italy.*)
2561. ELECTRIC ARC LAMPS, J. Jeffryes and J. Lea, London.
2562. FEEDING DEVICE for FURNACE GATES, M. Oschatz, London.
2563. FLUTE and FIFE TUNING APPLIANCE, C. Lillicrap, London.

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2564. LOCK NUTS and WASHERS, B. B. Dadley, London.
2565. STEAM and other ENGINES, S. Z. de Ferranti, London.
2566. BOILER FURNACES, W. Dickinson, Newcastle-on-Tyne.
2567. BATH, G. L. Lavington and E. A. Wright, London.
2568. RACK for HOLDING TOBACCO PIPES, F. Mason, Penarth.
2569. PRESSURE DEVICES, E. Dawson, E. Bentley, and C. J. Cockshott, Keighley.
2570. CHANDELIERS, C. Meason and T. Ford, Birmingham.
2571. SHAFT GOVERNORS, J. H. Mann and S. Charlesworth, Leeds.
2572. HORSE COLLARS, E. Garnier and S. J. Prescott, London.
2573. SCARF TIE and STOCK BAND, &c., J. Campbell, Dublin.
2574. METAL BOXES and RECEPTACLES, J. R. Courtney, Dublin.
2575. FLOWER HOLDER, E. Smith and T. P. Rennoldson, Banbridge.
2576. FLOWER HOLDER, E. Smith and T. P. Rennoldson, Banbridge.
2577. WORKING EMBROIDERING MACHINES, O. H. Webb, Manchester.
2578. ROLLER SKATES, P. E. Masey, London.
2579. HAIR CURLERS, J. E. Hulbert, Birmingham.
2580. PICKING BANDS, W. H. Eastwood and T. Amey, Manchester.
2581. BATHS, H. Sutcliffe, Halifax.
2582. CHIMNEY TOPS or COWLS, H. Sutcliffe, Halifax.
2583. HEARTH-RUGS and DOOR-MATS, &c., G. Ramsden, Manchester.
2584. FOG SIGNALLING for RAILWAYS, G. Bowman, York.
2585. MANUFACTURE of AXLE-BOX GUARDS, E. Rees, Blaenavon, Mon.
2586. BEARINGS, C. L. Jackson and D. Horsburgh, Manchester.
2587. EXPLOSIVE SHELL, S. W. Gillett.—(*The Action Gesellschaft für Cartonnagen-Industrie, Germany.*)
2588. COLLAPSIBLE BOXES, H. and A. W. Stevenson, Manchester.
2589. HORSESHOE PADS, R. Hedley, Manchester.
2590. FENDER MOULDINGS, W. and J. H. Oldaker, Birmingham.
2591. SILENCER, F. Hayes, Runcorn.
2592. COLLAPSIBLE CLOTHES HORSES, W. L. Struthers, Newcastle-on-Tyne.
2593. WEIGHING MACHINES, H. S. Patterson, Deane, near Bolton.
2594. GAS GENERATOR, J. M. K. Pennink, Germany.
2595. MAKING PICKERS for LOOMS, W. Holt, Manchester.
2596. FOG SIGNALLING APPARATUS, J. W. Blackburn, Manchester.
2597. PRODUCING CURRENTS of AIR, J. D. F. Andrews, London.
2598. CYCLES, T. B. S. Brereton, London.
2599. INDICATING the NAMES of STATIONS, F. Shelley, Luton.
2600. AUTOMATIC DOOR STOP, F. Hughes and J. C. Webb, London.
2601. ROPE LOCK, R. Falshaw, Harrogate.
2602. MACHINES for WEIGHING BALE GOODS, H. Pooley, Liverpool.
2603. FASTENINGS for SLIDING SASH FRAMES, W. Nicol, Glasgow.
2604. ELECTRIC ARC LAMPS, R. E. B. Crompton, London.
2605. CARTRIDGE CARRIER, R. G. Broadwell, London.
2606. SCRAPING HULLS, A. W. Gatfield and W. Clark, London.
2607. MAKING SHIPS RECOGNISABLE, L. H. M. Völckers, London.
2608. DEVICE for HOLDING MATS to FLOORS, M. Levy, London.
2609. MONEY-BOX, J. Harper and Co., C. H. Harper, and C. Spencer, London.
2610. BUTTON-HOOKS for BOOTS and SHOES, G. Nash, London.
2611. GLOBELESS CHIMNEYS for LAMPS, A. Z. Germains, London.
2612. CUT-FLOWER HOLDER, A. Gray, London.
2613. INTERNAL COMBUSTION MOTORS, A. H. R. Pulman, London.
2614. DYEING FABRICS BLACK, W. J. S. Grawitz, London.
2615. SOLDERING IRON, G. B. Harkes and C. E. Bacon, London.
2616. APPARATUS for ASCERTAINING TIME, &c., J. Harper, London.
2617. STREET-SWEEPING MACHINE, N. B. Millar and F. Mohle, London.
2618. WICK ADJUSTER for LAMPS, E. A. Humphrey, London.
2619. COOKING OVENS, F. W. Dye and J. Wells, London.
2620. OIL STOVES, J. A. Suppiger, London.
2621. SECURING PACKING CASES, J. A. Suppiger, London.
2622. CYCLE GEARING, E. Detoni, London.
2623. CONSTRUCTION of HAIR-PIN, A. J. Linnell, London.
2624. THAWING or UNFREEZING MEAT, G. A. Nussbaum, London.
2625. RECOVERING AMMONIA, T. Twynam and F. E. Matthews, Egham.
2626. ELECTRO-COPPER SHEATHING, J. H. Cox, Greenock.
2627. CANS, J. H. Moysey, London.
2628. ASHPANS and CINDER SIFTERS, J. H. Kenyon, London.
2629. INSIDE COVER for BARRELS, E. T. Hughes.—(*C. L. Friederichs and H. C. Fliege, United States.*)
2630. SPRAYING APPARATUS for PAINT, C. L. Burdick, London.
2631. CINDER SIFTER and ASH RECEIVER, M. Greenfield, London.
2632. SECURING BOAT DAVITS, T. R. Butler, London.
2633. CURING FISH, The Fish Utilisation Syndicate, Ld., and J. C. W. Stanley, London.
2634. BOOT FINISHING, J. Butcher and J. Clarke, London.
2635. SHARPENING RAZORS, W. P. Thompson.—(*L. Schwab, Germany.*)
2636. SUBSTITUTE for WHITELEAD, &c., R. Alberti, Liverpool.
2637. HATS and other HEAD COVERINGS, J. W. Cooke, Liverpool.
2638. GAS ENGINES, W. James, Liverpool.
2639. REVOLVING WARP GUIDES, E. G. Fields and the Great Grimsby Coal, Salt, and Tanning Company, London.
2640. TOBACCO JARS, J. Spring, London.
2641. SLIDE VALVES, W. Joyce, London.
2642. MANUFACTURE of SUPER-PHOSPHATES, F. W. Saatmann, London.
2643. TOBACCO BOX, G. H. Schofield, London.
2644. HOLDER for FLAT IRONS, G. W. Banks and W. E. Bosson, London.
2645. FIRE-ESCAPES, J. W. Wilkinson, London.
2646. FIRE HOSE, G. M. Evans, London.
2647. SHIPS, F. Cornwall, London.

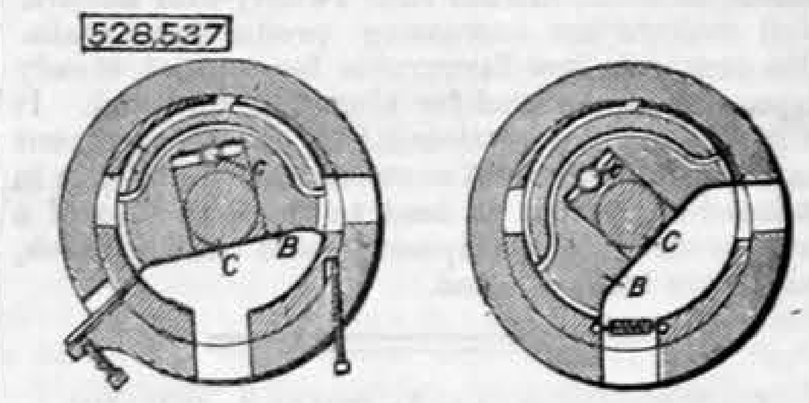
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

528,537. STEAM VALVE, *R. M. Fryer, Washington, D.C. —Filed December 26th, 1893.*

Claim.—(1) In a valve of the character described the combination of the cylindrical casing, the rotary valve therein eccentric to its chamber, and the compensating wedges movable in a circumferential direction between the valve and the walls of the chamber. (2) In a rotary valve the combination with the valve casing provided with steam and exhaust ports in angular relation to each other, the rotary valve therein, a chamber between the valve and its casing on the side opposite the exhaust port, and a communicating passage arranged to connect said chamber with the exhaust port when the valve is closed, the said chamber being so located relatively to the exhaust port that a straight line between the two will pass above the axis of the valve. (3) The combination of the rectangular shaft C, the grooved valve B mounted thereon, the tubular spring *c* interposed between the shaft and the valve, the spring being seated in channels formed in the respective parts and corresponding in radius with the external diameter of the spring.

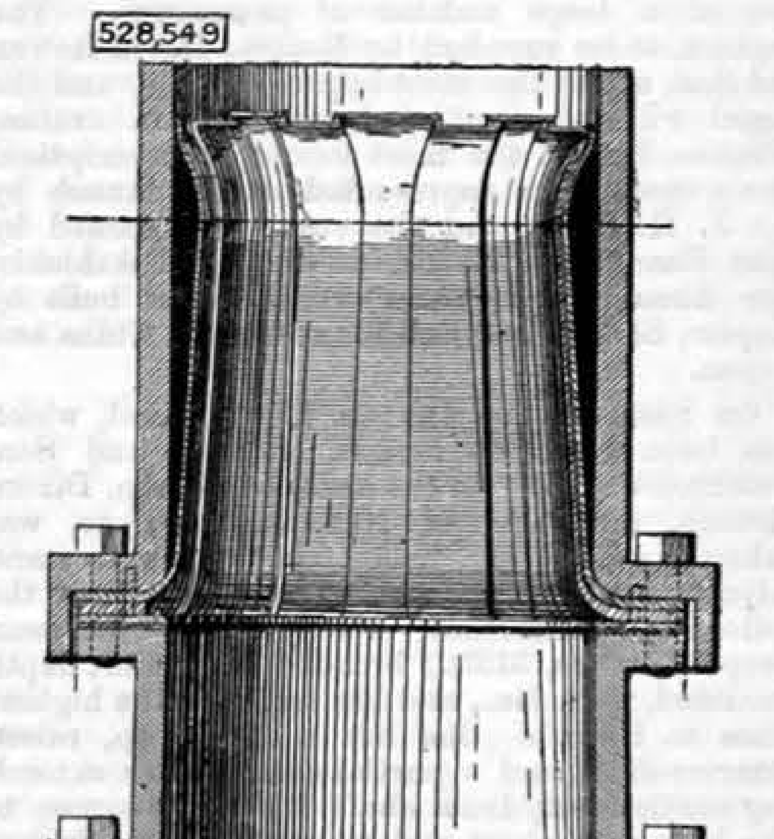
528,537



528,549. AUTOMATIC EXHAUST NOZZLE, *J. T. McLellan, Bozeman, Mont.—Filed January 16th, 1894.*

Claim.—The combination, with the exhaust sleeve or pipe, of the annular spring lining arranged therein and adapted to be distended by pressure of the exhaust steam, and to contract automatically and in a definite degree corresponding to the steam pressure, substantially as and for the purpose set forth.

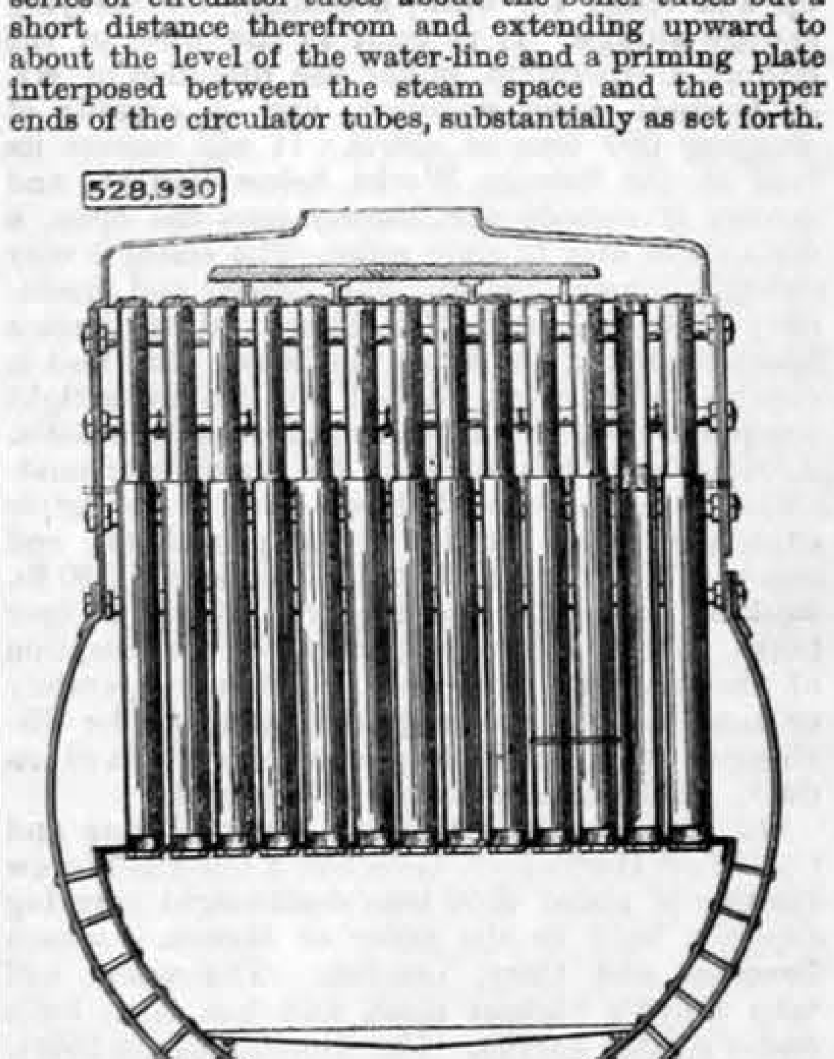
528,549



528,930. STEAM BOILER, *E. F. Edgar, Woodbridge, N.J.—Filed November 11th, 1892.*

Claim.—(1) In a steam boiler, a series of boiler tubes provided with incombustible walls located within and partially closing the tube at or about the water-line, but with draught spaces at the edges of said walls, a series of circulator tubes about the boiler tubes but a short distance therefrom and extending upward to about the level of the water-line and a priming plate interposed between the steam space and the upper ends of the circulator tubes, substantially as set forth. (2) In a steam boiler, a series of boiler tubes provided with incombustible walls located within and partially closing the tubes at or about the water-line, with draught apertures from one face of said walls to the other, a series of circulator tubes about the boiler tubes, but a short distance therefrom, and extending upward to about the level of the water-line and a priming plate interposed between the steam space and the upper end of the circulator tubes, substantially as set forth.

528,930



THROAT IRRITATION AND COUGH. — Soreness and dryness, tickling and irritation, inducing cough and affecting the voice. For these symptoms use Epps's Glycerine Jujubes. In contact with the glands at the moment they are excited by the act of sucking, the Glycerine in these agreeable confections becomes actively healing. Sold only in boxes, 7½d.; tins, 1s. 1½d., labelled, "JAMES EPPS AND CO., Homœopathic Chemists, London."