LITERATURE.

Eléments de Statique Graphique appliquée aux Constructions. First part by H. MULLER, Breslau; translation by T. SEYRIG. Second part by T. SEYRIG; with an Atlas containing twenty-six plates in 4to. Paris: Baudry and Co. 1886.

Vorträge über Brückenbau. By Dr. E. WINKLER. *Theorie der Brücken I.* Third edition. Vienna: Carl Gerold's Sohn. 1886.

THE last twenty years, perhaps more than any former period, are distinguished by a great progress in the art of calculating the stability of structures. The application of the laws of the equilibrium of forces and moments to the solution of statical problems, the use of the polygon of forces, and the theory of elasticity as applied to them, was to some extent known before; but the development of graphical and algebraical methods for the calculation of the continuous girder and the arch, the application of the principle of virtual velocities to the calculation of open-frame structures, and the successful investigations into the bending strains at fixed connections belong to this period. In this direction much greater results can be recorded than in the inquiry into the strength and duration of structures, or into the forces which act upon them. It is sufficient here to allude to the forces of a railway train in motion, to the vibrations transmitted through the foundations of a structure from without, to the molecular changes in parts exposed to vibrations, to the pressure of the wind the pressure of the earth upon retaining walls, and to the question of the factors of safety. The obvious reason why these investigations have not kept pace with the improvements in strain calculations is, that they can only be conducted by experiments, some of which require costly arrangements for the accurate measurement of very minute changes of form, while others must be extended over a considerable space of time.

The above-named two books, however, deal only with the strains in structures. The treatment in the French book is graphical, while in the German book the algebraical is predominant over the graphical treatment. The graphical method, developed almost to a science by Culmann, was hitherto applied only to a small extent in France, and the present book—which is partly a translation from the German, partly an original treatise by M. Seyrig on continuous girders based upon Culmann's method—is published with a view of making the graphical method palatable to French engineers. We do not intend to predict the result of this experiment, but we venture to think that its success would not be altogether free from the fault of directing ordinary capacities into a groove. All graphical solutions of a higher order are derived at present from algebraical analysis; but when the methods are once established their application becomes a matter of routine, and the derivation is easily lost sight of. One of the reasons for this being so is that very little resemblance exists between the solutions of various problems—for example, those of the continuous girder and the arch—and another reason, connected with the first, is the difficulty of varying a method which has been built up with great ingenuity. The algebraical solution, on the other hand, always begins with the same fundamental formulæ expressing the conditions of elasticity irrespective of the form of the structure. Great resemblance exists between the various problems of the continuous girder and the arch, while in matters of detail a great many ways lead to the result. Consequently the derivation of any particular method is not easily lost sight of, and anybody who is accustomed to algebraical methods finds less difficulty in the treatment of an exceptional case than he who is in like manner accustomed to graphical methods. French engineers, whose minds are trained in strictly scientific analysis more than in the use of ready-made rules, will therefore, perhaps, not adopt the graphical methods to any large extent.

In Germany Culmann's teachings have found a fertile soil in the craving for everything that is novel, and the number of his disciples is legion. Some of the most eminent expounders of the theory of strains in structures are prominently graphicists, while others have found it necessary, apparently in deference to the spirit of the time, to give graphical solutions after having completed the algebraical treatment. Thus Dr. Winkler, in the new edition of his "Vorträge über Brückenbau," adds two chapters on the graphical treatment of continuous girders, while in the principal portion of his treatise graphical figures are only used for illustrating the analytical process or the results.

The first of the two parts of the French book is by Müller-Breslau, and is divided into five sections. The first three sections contain the graphical method of the composition of forces in a plane, the theory of the polygon of forces, and of the funicular polygon, the curves of moments and shearing forces in a beam, and the construction of strain diagrams for systems composed of bars, such as trellis girders of various forms for bridges and roofs. The problems, explained in very clear language, and illustrated by numerous excellent diagrams, composed of black, red, and blue lines, are generally treated for given arrangements of the load. It is characteristic of the graphical process that a separate strain diagram is drawn for every arrangement of the load; and in order to find the maximum strain for any one bar, the greatest value for its strain would have to be selected from the various diagrams by comparison. But as all the forms here treated are such that the maximum strain in any flange bar is produced by the total load and the maximum strain in any web bar by a one-sided load, which is not the case in some other forms, it is not necessary to complete all the diagrams, and a way is also shown how one particular diagram constructed upon an abutment pressure equal to unity, may be used for the determination of all the maximum strains in the web-bars. In a treatise on graphical statics it would be unfair to expect to find also a treatment of other methods, especially the method of moments; but as it is a matter of controversy which of the two is the simpler one, an allusion to its existence might have been justifiable. The advantages of the latter are that the determination of the most unfavourable arrangement of the load for any given bar can be made direct from the diagram of the structure, even if that arrangement is more complicated than in the forms here treated, and that one equation of moments for each bar gives the result for the maximum strain in it without the comparison with other strains. A disadvantage of the method of moments is that sometimes the fulcra upon which they are taken lie far outside the diagram of the structure. In these cases a reduction of the scale becomes necessary, which is perhaps less convenient than to make use of the graphical method of decomposing one force into three others of a given direction. It should be remembered that both methods can only be applied to statically determined systems of bars, *i.e.*, those which can be divided in two parts by cutting through not more than three bars.

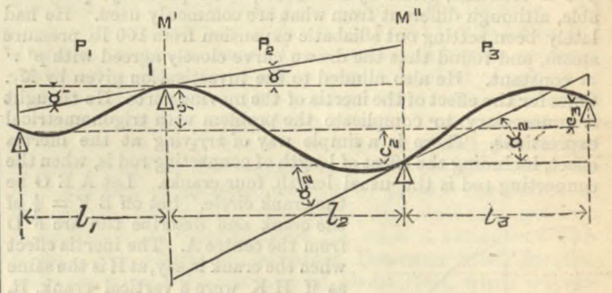
The fourth section treats of earth pressure on retaining walls. In the simple case of a retaining wall with a plane back, the direction of the earth pressure against it at the moment when slipping occurs is determined by the angle of friction, and the position of its resultant by the assumption that the pressure increases in proportion to the depth. Assuming that the surface at which the earth divides—the slipping surface—is a plane, the pressure of the underlying earth upon that surface is determined to the same extent. These two forces, not yet determined as to magnitude, are held in equilibrium by a third force, namely, the weight of the slipping prism, which is vertical, and passes through the centre of gravity of the prism. If the angle of friction δ is smaller than the natural slipping angle of the earth ρ slipping does not take place; therefore, further conditions for the state of equilibrium at the beginning of movement are that δ be a maximum and that $\delta = \rho$. The problem is to find the position of the slipping surface, which fulfils this condition, and the one that the three forces, as described, pass through one point. The magnitude of the two pressures are then determined according to the weight of the slipping prism by means of the triangle of forces. The problem is essentially a geometrical one, more particularly one of the geometry of position; and, in fact, all writers upon the subject have treated it thus, namely, graphically; for example, Poncelet, Scheffler, Rankine, Vaillant, Rebhann, Winkler, Mohr, Weyrauch, and others.

The present treatment by Müller-Breslau, resembles most that by Rebhann, but is in many points original. For comparison a chapter is added on Rankine's "Theory of Earth Pressure." It may here be mentioned that Dr. E. Winkler, not long ago, made a valuable contribution to this inquiry by an essay on the graphical determination of the earth pressure upon polygonal and curved surfaces of retaining walls (*Centralblatt*, 1885, p. 73). This section closes with a chapter on the stability of retaining walls.

The fifth section is a novelty, inasmuch as the theory of elasticity is applied for the first time to stone arches, while formerly it was usual to solve the problem by arranging a *possible* curve of pressure in the most favourable way about the central fibre of the arch. Although Rankine, Bresse, and other early writers on the theory of the elastic arch, did not, to our knowledge, exclude the stone arch from this theory, it is satisfactory to see the importance of the innovation clearly pointed out in so able an essay as the one before us. The only fault we have to find with it is that it appears under the heading of "Elements of Graphic Statics," while in point of fact the treatment is an algebraical one, with graphical illustrations. We also venture to think that if the author had made the elucidation of the theory his real aim instead of the demonstration that it is capable of a graphical illustration, he could have treated the subject on a much wider base within the same space, and perhaps with still greater clearness than he has now done. As it is, he is compelled to admit, after adjusting the general theory to graphical requirements, that it is accurate only for very flat arches; and when he treats of an arch bridge of more than one span he passes in silence over the fact that the adjoining two pressure curves are influenced by the elasticity of the pier. A graphical solution of this influence is possible; but, in our opinion, it is, so far as hitherto stated, much more complicated than the algebraical method.

The second part of the French book by M. T. Seyrig is devoted to an analysis of the bending moments and shearing forces in continuous girders. The method, which is graphical, sets forth the equation of the elastic line, as derived from the formula for the radius of curvature and from the law of the change of angle of two sectional planes across an elastic beam acted upon by bending moments in the same way as is done in the algebraical method. In the latter an expression is then deduced for the angle or for trigonometrical tangent of the angle, which the geometrical tangent on the elastic line at the supports forms with the horizontal; and as this angle is common to two adjoining spans, two such expressions form an equation, the number of equations being equal to the number of intermediate piers. The bending moments which appear in these equations as unknown quantities are then determined by a simple calculation. In the graphical method we are invited to imagine the elastic line to be a thin string suspended from the piers, *i.e.*, a funicular curve or polygon, which is loaded by *moments* and held in position, not by a horizontal *force*, constant from end to end, but by an *expression* containing moments of inertia and other quantities which may be constant, but which generally are variable along the line. This expression, named z'' by Culmann, plays an important part in graphic statics, and, as may be imagined, is a great stumbling-block to the beginner. In time, however, he becomes used to it, and may think he understands it, or he does not think and works by rote. In place of the equations in the algebraical process we have here also the consideration that the tangent on the elastic line at the supports is common to two adjoining spans, but in place of their solution we have a geometrical process derived from the geometry of position. The whole process is ingeniously contrived, its accuracy is sufficient for ordinary requirements, and is to a great extent insured by the way in which it furnishes its own checks; but as the author of the present essay points out—p. 281—the exactitude of drawing must be rigorous. When the diagram is completed it gives on one sheet of paper to those who are initiated into this particular treatment a complete picture, although a complicated one, of the whole process and its results. The author proceeds gradually from the problems of one span under different modes of fixture and different positions of the load to those of two, three, four, and five spans with reference to beams of varying cross section and also to the curves of influence for moments produced by a travelling load. The explanation by word is clear and elaborate, and the illustrations by diagram are satisfactory in every respect.

Near the end the author introduces the problem of an originally straight girder laid upon supports of different level, and illustrates it by two examples, viz., one where one of the four supports—a high metallic pier—is subject to an appreciable change of level in consequence of a change of temperature, and another where the girder, serving temporary purposes, had to be lowered on its supports by an intermittent operation. The process of calculation is also graphical, and it is shown that no particular difficulty is encountered. This is quite true, and we think the author, in introducing this problem, has made an important addition to his treatise on continuous girders; but when he says that the process is expeditious, compared with the algebrical calculation—p. 312—that Clapeyron's formulæ cease to be applicable if the level of one of the supports is changed, and more general formulæ must be resorted to—p. 342—and again, that Clapeyron's formulæ require supports of equal level—p. 352—we may be allowed to remark that in Clapeyron's formulæ, as they are usually stated, the tangents of the angles of the elastic line at the supports have already been eliminated, and that nobody is prevented from using them in their previous form. The tangent, multiplied with the adjoining span, need only be added to or deducted from the difference of level, and the equations are then as easily solved as if no difference of level existed. Molinos and Pronnier—"Ponts Métalliques," Paris, 1857—in their explanation of Clapeyron's ingenious method indicate this treatment – p. 39—but as, on account of the rarity of such cases, an example is not given, it may be proper here to make clear what we mean.



We write directly from this sketch:

$$c_1 - l_1 \tan. \alpha_1 = \int_0^{l_1} \text{funct.} \left(\frac{M',\ p_1,\ x}{E\,J}\right) d\,x$$

$$c_1 + c_2 + l_2 \tan. \alpha_1 = \int_0^{l_2} \text{funct.} \left(\frac{M',\ M'',\ p_2,\ x}{E\,J}\right) d\,x$$

$$c_1 + c_2 + l_2 \tan. \alpha_2 = \int_0^{l_2} \text{funct.} \left(\frac{M',\ M'',\ p_2,\ x}{E\,J}\right) d\,x$$

$$-c_2 - c_3 + l_3 \tan. \alpha_3 = \int_0^{l_3} \text{funct.} \left(\frac{M'',\ p_3\ x}{E\,J}\right) d\,x$$

We have written these equations in the general form, not specifying the mode of loading the beam or in what manner its cross section may vary from end to end. The expressions on the left side of the equations represent the vertical distances between the ends of the tangents and the supports, and it is assumed that these are small compared with the spans. Besides its simplicity this treatment has the advantage that problems of the nature of the first example—p. 343—can be solved without great trouble with due regard to the depression of the supports under the load. These depressions would be stated as functions of the compressibility of the piers and the pressures upon them; the latter would be simple functions of M', M", p and c. This, applied to our case, would give two more equations. Before any particular loading is taken into consideration, the six equations could be reduced to two; and from this point the operations with the various cases of loading would be nearly as simple, if the original straight beam rested upon elastic supports of different level, as if it rested on rigid supports of equal level.

Attempting to do this graphically, the author would not encounter insurmountable difficulties; but it would become evident that the algebraical process is the simpler of the two. Cases where the graphical method can at present be applied conveniently occur principally in class rooms, and in the design of a few types of actual structures. In practice the structures to be designed have a much more varied form, and questions frequently arise which either cannot be solved graphically at all or only with difficulty, and it is therefore important for the designer to have a method at his fingers' ends which will serve him in all cases; and such, in our opinion, is the algebraical method illustrated graphically.

We have already alluded to Dr. Winkler's book. Being already known by two former editions as a work of first importance on the statics of structures, it need only be referred to here on account of some valuable additions. These are a method of lines of influence generally and its application to special cases—*e.g.*, to continuous girders; a theory of continuous girders supported by elastic structures, for example by an elastic polygon; a chapter on the deflections of girders; also one on the determination of the uniformly distributed load, which corresponds to a system of concentrated loads; finally a graphical treatment of the continuous girder.

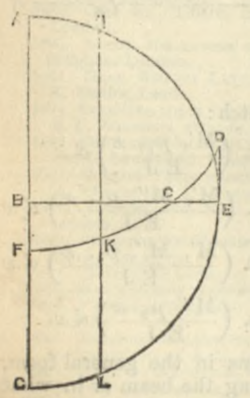
The analysis of the conditions of the elastic line is treated in the most general way, having regard to the influence, not only of the bending moments, but also of the transverse strains and the modulus of elasticity for shearing. It is then shown that usually this influence is very small, and that for practical purposes it may be ignored.

In the chapter treating of a continuous girder suspended from an elastic polygon, this problem is first solved without taking into account the vertical deflection of the polygon in consequence of the elongation of its parts, but at the end a more accurate theory is given which takes it into account. In this, as in other respects, the new edition contains more searching inquiries into the conditions of elastic and statically undetermined structures than the former editions; and although it may be doubted whether these inquiries are essential to the requirements of practical engineering, we can confidently assert that now and then cases occur in practice where such questions appear in the foreground, and that those who deal with them are bound to appreciate these more accurate theories if only with a view to estimating the probable errors of the calculations which are necessary.

The style of writing is masterly, and the arrangement of the chapters is sufficiently clear to enable the reader to form without difficulty an idea of the contents of the treatise. Great care has been taken with respect to the symbolising letters, each of which has its distinct signification throughout the volume, being in accordance with that given to them by most authors of the present time. In order to make the form in which the subject is moulded still more plastic to the eye, a variety of type orders is employed as well in the symbols and their composition into formulæ as in the explanatory text. The diagrams and sketches—the latter often in strong exaggeration of the conditions which they are intended to illustrate—are highly impressive, and are carried out in an unusually artistic style.

THE EFFECT OF INERTIA IN THE STEAM ENGINE.

In our report of the discussion on Mr. Coles' paper, read before the Institution of Naval Architects, we alluded to a diagram supplied by Mr. Macfarlane Gray, which we now reproduce below, and commend to the attention of our readers. Mr. Gray stated that the indices in the expression $p^8 v^9 =$ constant, given by Mr. Coles, were probably quite reliable, although different from what are commonly used. He had lately been setting out adiabatic expansion from 100 lb. pressure steam, and found that the drawn curve closely agreed with $p^8 v^7$ = constant. He also alluded to the investigation given by Mr. Coles for the effect of the inertia of the moving parts. He thought it unnecessary to complicate the problem with trigonometrical expressions. There is a simple way of arriving at the inertia effect, including the effect of length of connecting rod is, when the connecting rod is the usual length, four cranks. Let A E G be the crank circle. Set off B F = ¼ of the crank and describe the arc F D from the centre A. The inertia effect when the crank is, say, at H is the same as if H K were a vertical crank, R, making the same number of revolutions per minute, the inertia effect is then $\frac{N^2 R}{2936}$ W, where W is the weight of the moving parts. Since 2936 is nearly the square of 54, and 54 is very nearly the average rate of revolutions per minute for marine engines, it is convenient to deal with the problem as for that speed. The diagram can then be read thus, measuring the lengths in feet: When the crank is at H going down, the inertia effect amounts to H K tons per ton of moving weight. The *upward* force of the steam upon the cylinder cover is then H K × W tons more than the *downward* force of the steam upon the bed plate at the same instant. Similarly when the crank is at L going down, the inertia effect is K L × W tons; but its direction is now reversed, the downward force on the bed-plate is now greater than the upward force upon the cylinder cover. The static effect of weight of moving parts can be shown by describing another semi-circle from a centre in A G one foot *below* F, or otherwise by drawing the arc F D over again, one foot *higher* up. When the connecting rod is not the four-crank length, the curve F D can be drawn thus: Make B C = ·7 of B E, set off B F and D E, each the same part of the crank that the crank is of the connecting rod, and from a centre in the line A G or that produced, describe an arc through F and C, and draw a straight line from D to touch this arc. This construction, which is also only an approximation, is very accurate. The other construction is less accurate, but it is practically sufficient. It is obvious that the figures E A F D and E G F D can be read as the force diagrams of the action by which a working engine shakes the hull of a steamer.



The algebraic expression for R is—

$$R = x + \frac{x^2}{z} - \frac{(c^2 - r^2)(r^2 - x^2)}{z^3}$$

where

x = height of pin above centre of shaft,
r = length of crank,
c = length of connecting rod,
$z = (c^2 - r^2 + x^2)^{\frac{1}{2}}$ = vertical distance between the crosshead and the crank pin.

This is not given as necessary in practice, but only to show what the approximations represent.

COMPARISON OF LOCOMOTIVES, AUTOMOTORS, AND TRAM-CARS WORKED BY STORED-UP ENERGY.*

In calculating the weight Q of a locomotive which has to exert on the periphery of the driving wheel an effort E, the adhesion must, first of all, be taken into account. In fact, if α be the coefficient of adhesion in the case of a motor which is supposed to utilise the whole of its adhesion, the lower limit of the weight Q will be given by the formula

$$E = \alpha Q$$

whence

$$Q = \frac{E}{\alpha} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

A consideration of another nature will afford, in certain cases, a second lower limit, viz., the specific energy of the motor employed. In fact, under normal conditions, for a mean effort E, constant and sustained, which a motor must exert, it will have a maximum weight Q. What is here termed the "specific energy" of a motor is the coefficient $e = \frac{E}{Q}$ measuring the ratio of this effort E exerted by the minimum weight Q of the motor, this coefficient being fixed empirically. It is evident, *à priori*, that, for a given motor, the coefficient e has not an absolute value, nor is there any intention of giving it one in the following observations. There is then a second lower limit of Q given by the formula

$$e = \frac{E}{Q}$$

or

$$Q = \frac{E}{e} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This granted, a comparison of locomotives and automotive tram-cars may be made.

Let π = the weight in tons of the passengers carried,
and p = the weight in tons of the empty car;
then $p + \pi = q$.
Let r = the resistance in kilogrammes per ton of the car;
then $P = \frac{Q}{1000}$, the weight in tons of the locomotive.
Let R = the resistance in kilogrammes per ton of the motor,
and i = the rise of a gradient in millimetres;
then E = the tractive effort in kilogrammes at the periphery of the driving wheel.

Let us calculate P: (1) in the case of an independent locomotive, when we shall obtain

$$E = P(R + i) + q(r + i) \quad . \quad . \quad . \quad . \quad (1)$$

And the lower limit of P will be given either by

$$E = Q\alpha = 1000\,P\alpha \quad . \quad . \quad . \quad . \quad . \quad (2)$$

or by

$$E = Q\,e = 1000\,P\,e \quad . \quad . \quad . \quad . \quad . \quad (3)$$

according as e is > or < α.

In the case of an independent locomotive, there is no need to take into consideration the specific energy, because e is < α, and consequently the limit of P, determined by the coefficient of adhesion α, is higher than would be imposed by the coefficient of specific energy e. In such a case, therefore, it may be stated that

$$1000\,P\,\alpha = P(R + i) + q(r + i)$$

whence

$$P = \frac{q\,(r + i)}{1000\,\alpha - (R + i)}.$$

This result shows, as might have been foreseen, that for a load q drawn along a given gradient i, the weight P increases when the coefficient of adhesion diminishes, and that it only depends upon this condition. If it were question of a motor of specific energy $e < \alpha$, e must be substituted for α in this formula and the deductions made from it. Preserving the former values, let us calculate the minimum weight P of the motor in the case of the automotive car. In this case the conditions of adhesion do not immediately yield a lower limit of the weight P_1, because a portion of the weight necessary for adhesion will be borrowed from the car and its load, and the proportional β of the weight q to be utilised for adhesion is not indicated *à priori*. Under these conditions we shall have

$$E = (Q + 1000\,\beta\,q)\,\alpha, \text{ whence } P_1 = \frac{E}{1000\,\alpha} - \beta\,q.$$

The two limits of P_1 will therefore be

$$P_1 = \frac{E}{1000\,e} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$P_1 = \frac{E}{1000\,\alpha} - \beta q \quad . \quad . \quad . \quad . \quad . \quad (2)$$

By introducing these two equations into the calculation of P_1 the proportional β may be determined in such a manner that P_1 shall satisfy both limits at once. The minimum value of E as a function of the resistances is

$$E = (P_1 + \beta\,q)(R + i) + (1 - \beta)\,q\,(r + i).\dagger \quad . \quad (3)$$

Combining these equations,

$$\beta = \frac{(r + i)\,(e - \alpha)}{e\,[1000\,\alpha - (R + i)] + (r + i)\,(e - \alpha)}.$$

It follows from an examination of this expression that *cæteris paribus* (1) the proportional β is independent of the weight q of the car and passengers carried; (2) it increases directly as the gradient; (3) it also increases with the specific energy of the motor. Knowing the value of β, we obtain that of P_1 by the expression

$$P_1 = \beta\,\frac{\alpha\,q}{e - \alpha} \text{ deduced from (1) and (2)}$$

$$P_1 = \frac{q\,\alpha\,(r + i)}{e\,[1000\,\alpha - (R + i)] + (r + i)\,(e - \alpha)}$$

or

$$P_1 = \frac{q\,\alpha\,(r + i)}{e\,[1000\,\alpha - (R - r)] - \alpha\,(r + i)}.$$

Be it remarked in the first place that, in practice, 1000 α is always considerably greater than R − r, so that the term in e is positive. An examination of the value of P_1 shows that, other things being equal, (1) the weight of the motor increases directly with the gradient to be mounted; and (2) it diminishes as the specific energy increases. A direct comparison of the values of P in the case of the separate locomotive, and of P_1 in that of the automotive car, cannot give a sufficiently appreciable result. This ratio is in fact

$$\frac{P}{P_1} = \frac{e\,[1000\,\alpha - (R - r)] - \alpha\,(r + i)}{\alpha\,[1000\,\alpha - (R + i)]}.$$

But, taking $\frac{e}{\alpha} = n$, it may be deduced that the less the specific energy of the motor employed—that is to say, the more e diminishes in value and approaches α—the less is the ratio $\frac{P}{P_1}$.

When $n = 1$, that is to say $e = \alpha$, $\frac{P}{P_1} = 1$. In other terms, the automotive car would lose, in this case, all the advantages of its lighter motor, but in practice e is always > α. A concrete example will make more manifest the advantages of the automotive car. Let it be supposed that—

p = 1890 kilog.
π = 2100 kilog., reckoning 30 passengers at 30 kilog. each.
$q = p + \pi$ = 3990 kilog.
$r + i$ = 66 kilog.
R + i = 72 kilog.
$\alpha = \frac{1}{9}$

and let us seek the minimum weight P, and also that P_1 of the automotive car fulfilling these conditions. In this case e must have a special value; but, to keep within the mark, let $e = \frac{1}{7}$, though the specific energy of some steam motors does not greatly exceed ⅙.

The introduction of these values gives—

(1) In the case of the separate locomotive:

$P = \frac{22}{13}q$ = 6752 kilog.
$P + p$ = 8642 kilog.
E = 750 kilog.
$\frac{P + p}{\pi}$ = 4·11

(2) In the case of the automotive car:

$P_1 = \frac{21}{22}q$ = 3808 kilog.
$P_1 + p$ = 5698 kilog.
E_1 = 544 kilog.
$\frac{P_1 + p}{\pi}$ = 2·71
$\beta = \frac{3}{11}$

and

$\frac{P}{P_1}$ = 1·77
$\frac{P + p}{P_1 + p}$ = 1·51
$\frac{E}{E_1}$ = 1·378

The preceding figures have been taken by chance, but they correspond very nearly with the actual conditions of working presented by the gradient of the Boulevard Botanique, Brussels. At a speed of 1·1 metre per second, which is that of a horse walking, the motive force exerted by the separate locomotive would be 11-horse power, and that of the automotive car engine 7·97-horse power, for the same useful work. In the Boulevard Botanique three horses are required to draw the car. In the above calculations the values of R and r are supposed to be at their minimum. In town tramways the coefficient of adhesion is taken as one-tenth and even one-twelfth. The automotive car possesses, therefore, over the car drawn by a separate locomotive the following advantages:—(1) It has a lighter engine; (2) its dead weight is less considerable; (3) it diminishes the ratio of the dead weight to that useful for adhesion; (4) it requires less motive force for a given work. All these advantages increase with the specific energy of the motors adopted. But, on the other hand, the automotive car has the following disadvantages:—(1) Mutual dependence of the motor and the car—which, however, is greatly lessened in automotive cars having engines that may be disconnected; (2) necessity for a turntable or triangle for turning at the termini, one, however, which does not exist in the case of all automotive cars. The use of a triangle is, moreover, a question of space at disposal. Besides, as at Antwerp and Brussels, the drivers of separate locomotives often prefer using a triangle to uncoupling, shunting, and recoupling; (3) want of elasticity as regards variability of load. On a railway, where the train is composed of several carriages, this constitutes a drawback as great as the use of an insufficiently powerful locomotive. On a town tramway, however, the case is only the same as that of a tramcar with horse traction. At all events, automotive cars are generally able to draw an extra car after them; but this leads to an increased weight of motor.

The favourable influence of a high specific energy has been shown above. In automotive cars the use of an engine having a higher specific energy than that of locomotives would still further diminish the weight, and with it the necessary effort, the work, &c. In fact, taking the results obtained for the automotive car having an engine of the specific energy $e = \frac{1}{7}$, and seeking the minimum weight P_2 of a motor having a higher specific energy, $e = \frac{1}{5}$ for instance,

$e = \frac{1}{7}$		$e = \frac{1}{5}$	
$P_1 = \frac{21}{22}q$	= 3808 kilog.	$P_2 = \frac{15}{28}q$	= 2137 kilog.
$P_1 + p$	= 5698 "	$P_2 + p$	= 4027 "
E_1	= 544 "	E_2	= 427 "
$\frac{P_1 + p}{\pi}$	= 2·71	$\frac{P_2 + p}{\pi}$	= 1·91
β	= $\frac{3}{11}$	β	= $\frac{5}{7}$

and

$\frac{P_1}{P_2}$ = 1·78
$\frac{P_1 + p}{P_2 + p}$ = 1·41
$\frac{E_1}{E_2}$ = 1·27

Under the same conditions of speed, 1·1 metre per second, the work of the automotive car having a specific energy would be 6·26 instead of 7·97 horse-power for a given useful effect.

It is now apparent that the use of steam indirectly, through the action of a stored-up force, may be advantageous, though this may have before appeared paradoxical. In the electric car, for instance, the ratio of the dead weight $P_1 + p$ to the useful weight π is reduced to 1·78. This method of traction possesses other advantages, as follow:—(1) It suppresses the transport of the coal and water necessary for the generation of steam; (2) it permits of slack being used instead of non-sulphurous coke, which in many countries would effect a saving of 50 per cent.; (3) it permits the use of improved engines, which require only a minimum of fuel.

* From the Jurors' Report on the Antwerp Trials of Mechanical Traction for Tramways.

† It is here supposed that the portion of the car's weight which contributes to the adhesion creates a resistance to the motion of R kilogrammes per ton, although this value is evidently excessive. The hypothesis is, therefore, unfavourable to the automotive car.

Liverpool Engineering Society.—The usual fortnightly meeting of this Society was held on Wednesday, May 5th, at the Royal Institution, Colquitt-street, Mr. Coard S. Pain, Assoc. Inst. C.E., President, in the chair. A paper by Mr. J. N. Shoolbred, B.A., M. Inst. C.E., entitled, "Tidal Works on the Seine, and on other Rivers," was read by the author. The river Seine is affected by the flow of the tide for about ninety-three miles above Havre, of which the upper fifty-two call for no remark. For the next twenty-five miles lower down the channel has been confined, where required, within a narrow width, and its navigable bed considerably improved by means of H.W. training walls of rubble stone. The result has been to reclaim 20,000 acres of slob lands behind these walls, which formerly formed part of the bed of the river. These works were begun in 1845, and ended in 1867. The estuary, sixteen miles long, forms the lowest portion of the tidal compartment. Soon after the completion of the river walls, accumulations of sea-borne sand from the coast of Calvados began to be felt in the north-eastern part of the estuary, in consequence of the river being no longer available. These accumulations have been gradually extending seawards, till their area amounts to about 40,000 acres. The tidal capacity of the estuary has been diminished by one-third. The entrance of the port of Havre is now very seriously threatened, the yearly accretions in its vicinity having amounted for some time past to about eight millions of cube yards; so that the earlier improvement in the navigation of the river Seine threatens to be more than counterbalanced by the deterioration of its estuary. The reclamation works on the Gironde, the Dee, and the Ribble are then briefly described, as also are the improvements by dredging on the Clyde, the Tyne, and the Tees. The Mersey is then touched upon, and also the effect upon it of the several proposals made in connection with the Manchester Ship Canal, with illustrative examples, such as the Thames and Avon, in addition to the preceding, which bear upon the matter in question.

as, for example, the discovery in blast furnace hearths of what was known as Ferrous Amianthus, a curious aggregation of fibrous globules of a silicate of Titanium. This was a matter of much interest, and up to the present no satisfactory explanation had been given of the cause of its formation, or how the silica came there, nor was the nature of the conditions necessary to its production understood. Again some curious crystallised blast furnace slag had been brought under his notice, similar to crystals that had been found in the Oldbury furnaces. This had been analysed for him by two of his former pupils, with the result that Spinelle—ruby—was present, artificially formed. Dr. Percy spoke gracefully and with feeling of the old pupils at the School of Mines in Jermyn-street, and said that the greatest pleasure a teacher would have was to find his pupils advancing in knowledge and prosperity.

He next directed attention to two curious products of the East, one a cast iron pan about 2ft. 6in. in diameter and 1ft. deep, used in China for cooking rice. This pan is extremely thin, especially near the edges. An attempt had been made to produce some in this country, but the Chinese would not have them, as they were too thick and required too much fuel to heat them. As to the actual mode of production in China nothing was known, and he hoped some of his audience would be able to explain of what the moulds were made, and whether they were heated or not before the metal was poured. Such pans were of considerable antiquity, and Count Rumford had described them in 1802. Unfortunately the pan on the table had been cracked. In China cracked pans of the kind were common, but the Chinese tinkers could mend them, and did so, he understood, even when they were not only cracked, but broken into fragments. How was this mending effected? He then produced from his pocket a much greater curiosity, an anklet worn by East Indian women. This is a flat curb chain about 1in. broad, with the links very close, and weighing about ten or twelve ounces. It is composed of a species of brass composed of copper and lead, without any trace of silver, zinc, or tin. Such anklets are sold for a few pence, and they are cast all at once, complete as an endless chain. The links show no sign of having been united in any way. How, Dr. Percy said, it was possible to produce such a casting as this passed his comprehension, and he earnestly hoped that someone who had seen them made would explain the nature of the process. From the East much that was curious in metallurgical art came. Cast iron was, he believed, first made purposely in China. It was, however, frequently produced unintentionally, when wrought iron was made direct from the ore in little furnaces about as big as a chimney-pot. It was found among the cinders and ash of the charcoal fire in grains or globules, which were not only like shot, but were actually used as shot by the natives. He showed what he believed was the only specimen in England of this cast iron, in a bottle. He next referred to the celebrated Damascene blades of Indian swords, of which an interesting exhibition was shown by a West-end firm, and explained that these blades were really an intimate mixture of wrought iron and hard steel, which must have required great skill, time, and patience for its production. One pattern in particular, known as "Mary's Ladder," showed a ladder-like pattern of wonderful finish and accuracy. Concerning the tempering of these blades little was was known; but it was stated that it was effected by a long-continued hammering, or rather tapping, of the blade while cold. Concerning one famous sword, it was said that one man spent a whole year in thus tapping it. It was possible that some obscure molecular change might thus be brought about in the metal. He would have liked, Dr. Percy said, to speak of Japanese metal work, but time forbade him. In China there were vast stores of as good coal as existed in the world, and an abundance of iron ore, so that in that country vast quantities of iron would no doubt one day be made. The superstitions of the people, who held that the mines were protected by tutelary deities, whose anger must not be provoked, had stood in the way hitherto, and prevented them from being worked; but this would not last for ever.

After paying warm thanks to the Scotch members, and to Mr. Riley in particular, for their exceeding hospitality to the Iron and Steel Institute at Glasgow last year, Dr. Percy went on to speak of the gloomy condition of the iron and steel trade. No doubt excessive production was the cause of the prevailing low prices, and it would be wonderful, if we considered the gigantic quantities of iron and steel which were made in this country, that prices should keep up. But over-production was not confined to England. All the other metallurgical nations were running in the same race. We had to compete with men who worked for a mere pittance, barely enough to keep body and soul together. The recent riots in Belgium, although deplorable and reprehensible in the extreme, showed that the men could not much longer submit to their misery; and if wages went up abroad, competition would no longer be so severe at home and matters would improve—unless, indeed, our own workers followed the example of those of Belgium. It was, he thought, safe to say now that steel and iron could not be made more cheaply in this country than they are. Yet, while we got but £3 15s. per ton for finished rails, German firms had, to his own knowledge, offered to supply equally good rails at £3 3s. per ton. The question of ores was rapidly becoming of great importance. The finer ores were becoming scarce, and Bilbao could not last for ever. There were fine deposits of hematite in South America, but no means existed for getting it down to the sea.

He had spoken, Dr. Percy said, "of over-production of iron; he must now say a word of the over-production of men." So much care was taken now of human life, and so great was the interference with natural laws, that it was absolutely certain that a time must come when the earth could not supply food for its human inhabitants. It had been said that if the forests of North and South America were cut down, the ground saved would support 2,000,000,000 of people; but it must be remembered that we are dependent on the leaves of trees for the removal of carbonic acid from the air and the evolution of oxygen; and if this vast area was cleared of timber, it was open to question whether the grass and corn grown in its stead would accomplish the same process of purification. Still, all this was in the distant future, and beyond all question emigration was at present the great relief for surplus population, and should be far more freely practised than it was. Dr. Percy concluded his address with a reference to trades unions, and to the Colonial and Indian Exhibition, and sat down amid great applause. The address, the general features of which we have indicated, occupied over an hour, and was delivered with much spirit. Dr. Percy's style is, we need hardly say, nervous and excellent. We think we may say safely that we have never heard an address of the kind which was better or more satisfactory in any respect.

After a cordial vote of thanks had been passed, the President presented the Bessemer medal to Mr. Williams, jun., to be conveyed by him to his father, who was unfortunately unable to receive it in person. Then Mr. Philip W. Flowers, of Neath, read a paper

ON THE ORIGIN AND PROGRESS OF THE MANUFACTURE OF TIN-PLATES.

Mr. Flowers sketched the history of the manufacture of tin-plates. The Rev. Mr. Britton, writing in 1810, explains that the attention of the county was first excited to this lucrative branch of manufacture in the reign of Queen Elizabeth, 1558-1603, and made rapid progress. It was then checked by the troubles in the time of Charles I., 1625-1649; and when agriculture came in again the forests were neglected, and large herds of goats destroyed the woods, which were essential for charcoal-burning. However, following the introduction of pit-coal for iron-making, a sudden renewal of the works took place in 1770, and in that year there were eight charcoal forges existing, five of which were owned by Harford, Partridge, and Co., viz., at Machen, Gelliwastad, Bassaleg, Caerleon, and Monmouth, Pontypool Forge and Tin Works, owned by Mr. G. C. Leigh, tin mills at Rogerston and Caerleon, and charcoal wire works and forges at Tintern and Abercarne. The most noteworthy dates in the history of the trade are: —1728, the introduction of sheet iron *rolling* by Major Hanbury, of Pontypool, which was described at that period as the "art of expanding bars by compressing cylinders." 1745, the employment of a grease pot to warm and prepare the iron for receiving a coating of tin. About 1770, the application of pit-coal as a substitute for charcoal in the manufacture of iron. In 1806, the substitution of vitriol for barley-meal as a medium for pickling purposes. In 1807, Mr. Watkin George, of Pontypool, introduced the dandy fire as a preliminary process for the refinery, and the brick hollow fire as a substitute for balling. In 1829, Mr. Thomas Morgan introduced cast iron annealing pots, as a substitute for annealing in an open furnace. About 1849 the black pickling by vitriol was introduced as a substitute for scaling. In 1866, patent rolling, so called, of the tin-plates as they leave the tin pot was introduced by Mr. Edmund Morewood, of London, and Mr. John Saunders, of Kidderminster. In 1874, pickling machines were generally introduced as a substitute for hand labour. In 1875, the introduction of Siemens soft steel as a substitute for charcoal iron. In 1880, the adaptation of Bessemer steel as an equivalent for puddled bar iron. In 1883, the introduction of basic steel blooms from Middlesbrough in competition with Bessemer bars.

The author described at length the open-hearth Siemens steel process. The employment of Siemens steel bars as a substitute for charcoal bar iron marks a period which must always remain memorable in the history of the tin-plate trade. The object of the charcoal forgemaster has been, for ages, to produce an iron which would fold and stamp and bend to meet the severest tests of tin-plate conversion, and up to 1875 he had been able to hold his own under all competing circumstances. It was the pride and pleasure of his life to boast that the open-hearth refinery system had stood unchallenged since the time of the Romans, and he believed that the manufacture of charcoal forged iron was placed beyond the risk of ordinary trades. He was right upon the question of quality, for it can never be fairly said that steel superseded charcoal iron upon its merits as a metal, for charcoal iron has made and can still make deeper stampings than steel. Sir William Siemens worked for years to produce a competing material, and eventually, by cost, he mastered the situation. The introduction of open-hearth steel as the foundation for charcoal tin-plates, dates, commercially from 1875, when the Landore Works were under the direct management of Dr. C. W. Siemens. A preliminary irregularity, however, was gradually surmounted, and as gradually the trade expanded, until in 1880 the Landore Company was sending out 600 tons of bars weekly. The successful manufacture at Landore created a revival of the Elba Works, near Swansea, about 1878, which was followed by the construction of ten new furnaces in South Wales.

Birchgrove Steel Company	2 furnaces,	Swansea Valley,	1880.
Morewood and Co.	2 ,,	Llanelly,	1880.
,, ,, ...	2 ,,	Cwmbwrla,	1882.
Leach, Flower, and Co. ...	2 ,,	Neath,	1883.
John S. Tregoning and Co.	2 ,,	Llanelly,	1885.

The three important advantages which are claimed from the employment of steel may be stated as follows:—(1) Economy in the waste which results from the conversion of bar iron into black-plate. (2) A reduction in the percentage of waster tin-plates. (3) A reduction in the weight of coating metal, resulting from the smoother surface of steel black-plate. The furnace itself, which may be roughly described as a punt-shaped bath, is constructed of cast iron shell plates lined with silica fire-bricks, and the bottom is formed by a thick coating of fused silica sand. A convenient bath measures 9ft. by 15ft., and holds about ten tons of molten metal, and remains under heat for a period of thirty weeks, when a fourteen days stop is necessary for cooling, repair, and re-heating. The gas—for heating—which is manufactured outside of the cast-house, is introduced by means of ports situated above the metal, and flows in and out of the furnace by means of valves. The heat is created by a combination of gas with heated air, which produces an initial temperature of nearly 4000 deg., the flames of combustion afterwards retiring at nearly 3000 deg. Fah. The foundation of the ingots is hematite iron, which is selected as containing the smallest percentage of phosphorus and sulphur which is to be found in English pig iron. The disadvantage of phosphorus is to render the metal brittle when cold, whereas extreme toughness when cold is the quality desired. As pig iron, of itself, is slow in coming to "nature," it is found desirable to add a certain percentage of steel scrap, which enables a larger production, but brings no advantage to quality. The pig iron is charged upon the bottom of the furnace, and the scrap is placed above it, and principally upon the sides, so as to catch the strongest heat. After remaining for about three hours under heat, the metal becomes liquefied and begins to bubble; the melter then throws in a few cwts. of rich Spanish ore. The result of this operation is that the ore eats up the carbon, which is necessary to remove, and causes the silicon to be eliminated by the oxidation which is set up by agitation of the metal. Additional quantities of ore are added over the next three hours, which eventually reduce the carbon and silicon to such a point that the metal begins to boil violently over. This ebullition continues for three or four hours, during which period the carbonic oxide gas blows off from the face of the metal like candles or jets of gas, until the iron ore, having calmed down the fury of the carbon, the mass of molten metal becomes quiescent. The wear and tear of the furnace is refurnished daily by the employment of well-dried silica sand. When the metal has ceased to produce carbonic oxide flames, it is the duty of the melter to ladle out a sample, which, after being cooled in water, is tested roughly by hammering, and subsequently in the laboratory. In the laboratory the sample is drilled, and the drillings when weighed are placed in a glass tube, mixed with diluted nitric acid, and boiled until brown fumes appear. When the brown fumes change into white, and by the colour which then appears—viewed under advantageous circumstances—the chemist is able to say whether the metal, then in the furnace, is higher or lower in carbon than the standard test with which it is compared. If too much carbon is found to be present, the melter throws in a little more ore, and subsequently tests again. When the chemist announces that the charge is equal to standard, the order is passed for tapping the furnace. As the molten metal passes down the shoot to the ladle, the second furnaceman throws in at regular intervals coarsely powdered red-hot ferro-manganese, the effect of which is to destroy the "red-short" quality of the metal, rendering it ductile, and easily forged when hot. The destruction of carbon by the use of iron ore and the elimination of silicon creates a softness and toughness in the metal, which can be hardened or softened at will, by proper regulation of the carbon, and it is by this means that steel or ingot iron is rendered specially suitable for such a variety of purposes. The efforts to introduce Bessemer steel for tin-plate purposes were commenced about 1864, when experiments were made upon Dowlais bars by the late Mr. Joshua Williams, who was at that time the managing partner of the Aberdulais Works. The first intention was to compete with charcoal iron, but the attempt had to be abandoned in consequence of apparently capricious variation in the toughness of the sheets. The bars would vary for softness within their own length, the substance of the bars would also vary, and hard bars would constantly smash up the old-world machinery which was then in use. These endeavours to compete with high-priced charcoal iron having failed, competition ceased until Bessemer bars dropped to a price which permitted the use as a substitute for puddled bar iron. It will be understood that as a material for canisters, and for similar work, that steel escapes the tests which are inevitable for a better class of trade. For stamping purposes, and for the higher grades of tinsmiths' work, every sheet must be a certainty, or the "result" becomes positively valueless, and the loss upon first cost of the material is frequently almost doubled by duty and transit charges. For canister work, however, Bessemer steel is good enough, and a market has been opened out for at least 300,000 tons of bars yearly so long as suitable quality can be furnished at about the cost of home-made puddled iron.

The following table will very briefly explain the actual progress, over more than 100 years, of this now important manufacture, consuming annually 460,000 tons of British iron and steel, which would be absolutely valueless for similar purposes if it were not for the protection which the coating affords.

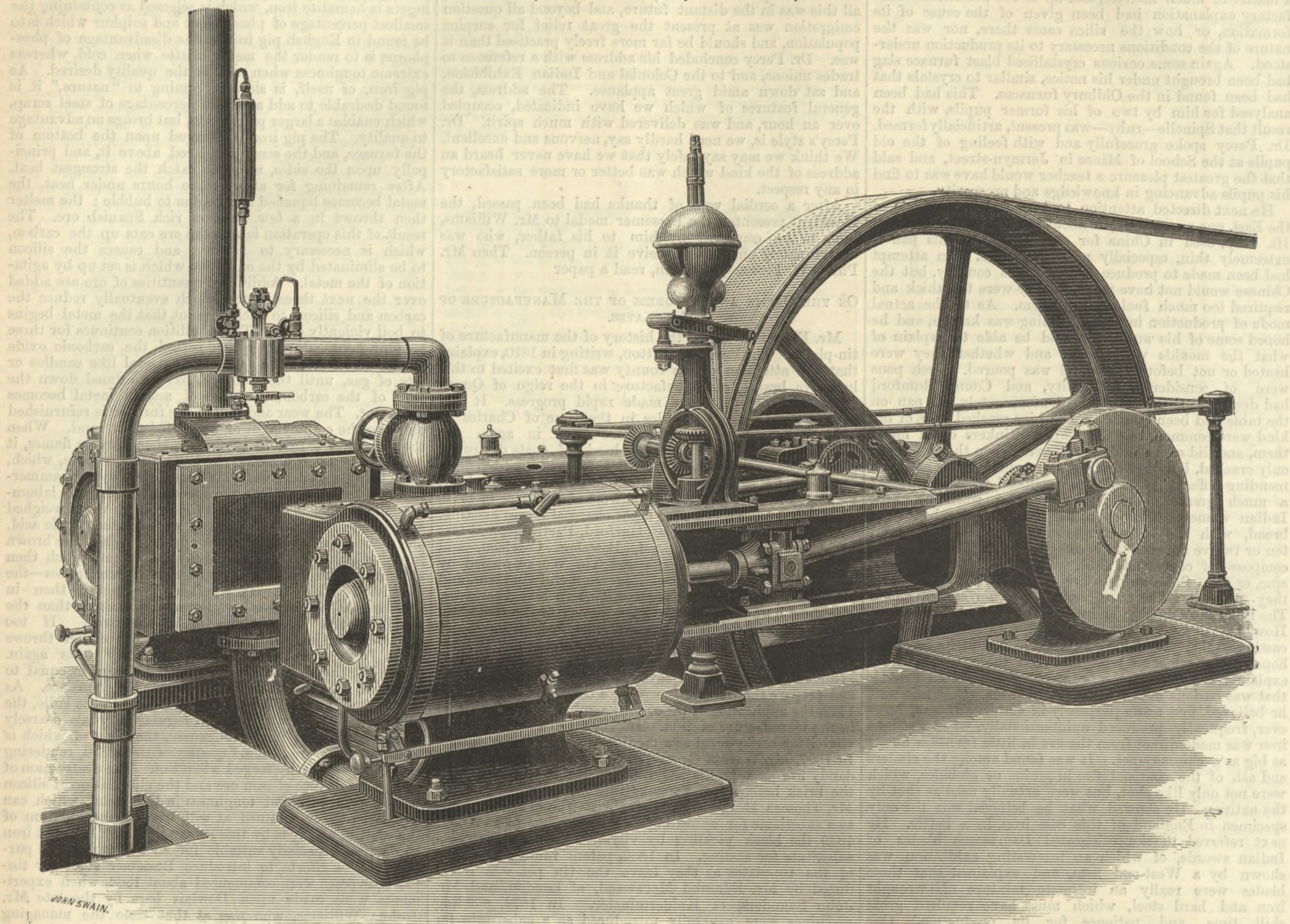
Works existing in	1750	1800	1825	1850	1860	1865	1870	1875	1885
Glamorganshire ...	...	2	4	8	12	15	19	27	44
Monmouthshire ...	2	4	6	11	12	12	15	16	20
Carmarthenshire ...	2	2	2	3	4	5	8	14	17
Staffordshire	...	...	1	7	7	8	9	9	6
Worcestershire ...	...	...	1	2	2	3	3	3	2
Gloucestershire ...	...	...	1	1	1	1	1	1	2
Scotland	...	...	...	...	...	1	1	1	2
Herefordshire... ...	...	1	1	1	1	1	1	1	1
Flintshire	...	...	...	...	...	...	1	2	1
Cumberland	...	...	...	1	1	1	1	1	1
Total works ...	4	9	16	34	40	47	59	75	96

Estimates of 1884 production	320 Mills.	One Mill.
Per annum of thirteen months ...	6,896,300	21,550
,, month of four weeks...	530,461	1,658
,, week of six days...	132,615	414
,, day of twenty-four hours... ...	22,102	69

The estimated output of 21,550 boxes per mill per annum is based upon the combined average of returns made to the Board of Trade, and of payments to the Swansea Association. If we take it that three-fourths of the entire production is employed for canister purposes, 3,000,000 boxes would produce 875,000,000 of 1 lb. canisters. By means of these canisters Europe receives largely of beef from the Western Prairies, salmon (in ship-loads) from Oregon, mutton from the plains of Australia,

COMPOUND ENGINE—COLONIAL AND INDIAN EXHIBITION.

MESSRS. DAVEY, PAXMAN AND CO., COLCHESTER, ENGINEERS.



fruit of all sorts from California, lobsters from Boston and Nova Scotia, oysters and peaches from Baltimore, sardines and green peas from France, pine-apples from Mauritius, apricots from Lisbon, milk from Switzerland, jams from Tasmania, and many other products of foreign soil, which complete the list of what the French have termed *conserves alimentaires.*

The discussion which followed was not of any importance, and was mainly remarkable for a defence of his metal made by Sir H. Bessemer, and some remarks made by Mr. Head, representing Messrs. Siemens, of so personal a nature that he was called to order by the President. In his reply, Mr. Flowers said that he regretted having made an error as to the date of Mr. Bessemer's experiments in London. Whatever might be said concerning the merits of Bessemer steel tin-plates, the hard commercial fact could not be got over that purchasers who wanted the best tin-plates would have Siemens metal and not Bessemer. Sir Henry might produce any specimens he pleased, but purchasers who were working up as many as 100 boxes per day ought to know what suited them best. Sir Henry lived in a world of theory, but the tin-plate makers lived in a world of trade, and could not force on the purchasers what they would not buy. No one in the trade had put up a Bessemer converter. All experience went to show that the inequality of the material rendered it unsuitable for best work, as one end of a plate would be hard and the other soft, and on analysis a different result could be got from the two ends of a Bessemer bar.

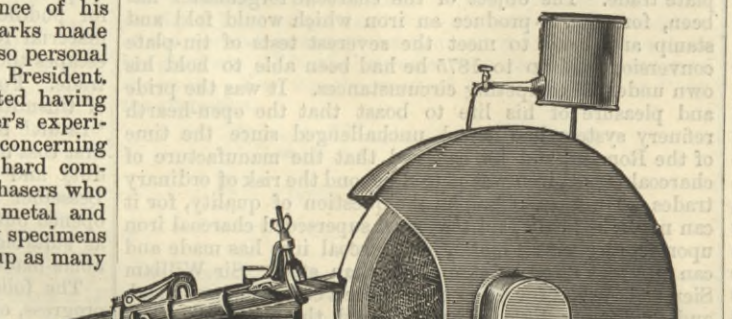
This, as we have explained, concluded the proceedings for the day in a very unexpected way.

Proceedings were resumed yesterday — Thursday — morning, and papers were read, a notice of which we must reserve for our next impression.

ELECTRIC LIGHT SHED, COLONIAL AND INDIAN EXHIBITION.

ON the next page we illustrate the interior of the electric light shed, fitted with engines and boilers by Messrs. Davey, Paxman, and Co., Colchester. This firm, who supplied the engine and boiler power necessary for working the whole of the vast system of electric lighting throughout the late Inventions, Health, and Fisheries Exhibitions, have again been retained for a similar service. The engines will develope 1200-horse power, and are as follows :—

No. 1 engine is a compound semi-fixed engine placed beneath the boiler, and capable of developing 120-horse power. The two largest engines, Nos. 2 and 6, are of the coupled horizontal non-condensing type, and capable of developing 700-horse power if required. Fixed between these are three compound engines, Nos. 3, 4, and 5, No. 3 being on the coupled compound girder system, whilst Nos. 4 and 5 are of the horizontal compound receiver type. Nos. 7 and 8 are new vertical compound quick speed engines, which can be employed for driving dynamos either direct or otherwise. No. 9 is a small quick speed engine, driving the dynamo on an entirely new system. All the above engines are provided with Paxman's patent automatic cut-off gear, worked direct from the governors, so as to ensure very steady and even running ; the advantage of this system is that only just sufficient steam required for the duty is admitted to the cylinder at each stroke of the piston. This is one of the



SHIRLAW'S TWIST DRILL GRINDER.

very few automatic arrangements which work with regularity and certainty. The cylinders are steam jacketted. It may be mentioned that at the Health Exhibition, 1884, one of the large driving bands on one of the engines suddenly broke, when the engine was transmitting about 350-horse power, but the automatic gear, even in this extreme case, prevented the engine from over running. Steam is supplied to the semi-fixed engine by its own boiler, while that for the remaining engines is generated in eleven steel boilers of the locomotive type, each containing 610 square feet of heating surface, and working at 120 lb. steam pressure. The fire-boxes are of Davey, Paxman, and Co.'s improved mild steel, which has given such excellent results. Above the boilers is placed a wrought iron steam receiver, so as to insure perfectly dry steam.

In addition to the above, Messrs. Davey, Paxman, and Co. have an 8-horse power horizontal engine driving stamps for extracting gold from ore, in a building erected by the Queensland Commission on the South Promenade; also a 4-horse power "Standard" vertical engine driving one of Paxman's patent safety machines for extracting from the soil diamonds and other precious stones. This machinery is in the South African Court. The steam for these two engines is supplied from Davey, Paxman, and Co.'s range of boilers in the electric light shed.

We illustrate above one of the two new compound engines just referred to. They are compact, substantial, and well-designed engines, of excellent finish and proportions, and will no doubt perform their work admirably.

SHIRLAW'S TWIST DRILL GRINDER.

THE neat arrangement of twist drill grinder illustrated herewith is made by Messrs. Shirlaw and Co., of Berkeley-street, Birmingham. It has a very simple holder, so that the drill is evenly ground with a proper cutting angle, the angle at which the drill is held being adjustable. It has, as shown, a cast iron trough and hood. It has a Bilston grindstone on a steel spindle running in long bearings, protected against grit. The compound slide rest and telescope tool holder, with dividing arrangement, are all clearly shown in the engraving.

THE FORTH BRIDGE.

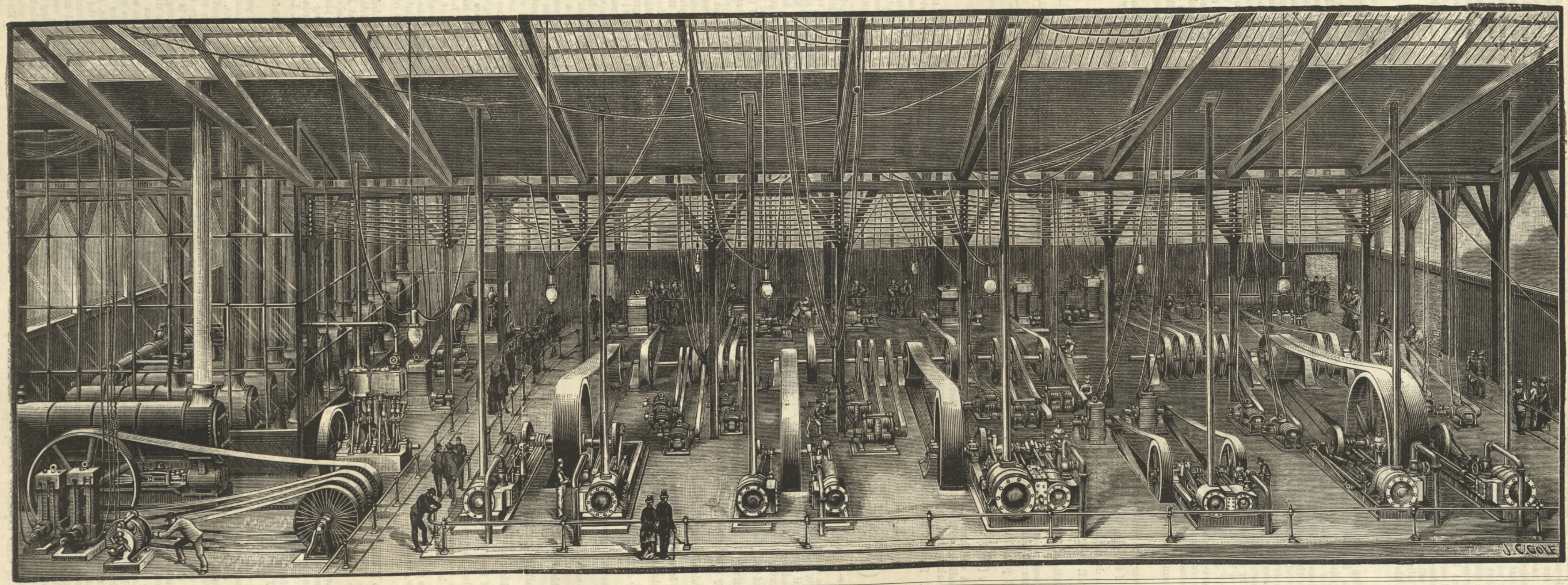
THE twelfth quarterly report of inspection by Major-General Hutchinson, and Major Marindin, of the works in progress for the construction of the bridge over the river Forth, has been issued. It states "that this inspection has been made later than it would otherwise have been in consequence of the snowstorm at the beginning of the month of March, by which storm we were prevented from reaching Queensferry at the proper time." Why this almost farcically useless inspection is made at all is one of those standing puzzles that no fellow can make out. The report contains very little more than a statement that the hard winter has impeded work, but that progress has been made and certain things done. The statement of things done being about the same sort of thing as a man at work on the bridge would send in a letter to an interested fellow-worker away on convalescent leave. In apparently this sort of manner the writers of the report are informed that "up to the present date 304,953 cubic feet of granite have been delivered, and about 269,000 cubic feet set. About 89,700 cubic yards of rubble masonry and concrete work, requiring the use of 16,200 tons of cement, have been executed. The four skew-backs for the North Queensferry piers are in course of erection. The skew-backs for the two South Queensferry south piers are put together in the yard, and the remaining two for South Queensferry and the four for Inch Garvie are all well advanced.

"Including the horizontal tubes for North Queensferry and Inch Garvie now being erected, 2500 lineal feet of tubes 12ft. in diameter, and 2900 lineal feet of tubes 8ft. in diameter, have been fitted and drilled. Of the lattice girders, tension members, and bracing girders, about 5800 lineal feet are ready for erection, and the top junctions are well advanced. About 20,970 tons of steel have been delivered. The average number of men employed on the works during the last quarter has been about 2000." As this report could equally well have been written in London, it is a pity that the two Majors should have gone a long journey to see the works in a snowstorm or covered with snow.

THE ELECTRIC LIGHT SHED, COLONIAL AND INDIAN EXHIBITION.

MESSRS. DAVEY, PAXMAN, AND CO., COLCHESTER, ENGINEERS.

(*For description see page 372.*)



THE AMALGAMATED SOCIETY OF ENGINEERS.

At a somewhat later date than usual, the annual report of the Amalgamated Society of Engineers has been issued to the members. It contains, however, no good news that might have been an inducement to hasten its publication, and any anxiety the members may have felt for its appearance must have been, not to learn how much progress the Society had made during the past year, but to know to what extent it had moved backwards as the result of the severe strain which has been brought to bear upon its resources by the protracted and extreme depression in trade. In his introduction to the report, which gives the thirty-fifth annual record of the Society's operations, the general secretary, Mr. John Burnett, very truly states that they cannot congratulate the members on having passed through a prosperous year. Both our home and foreign trades had been terribly depressed; the depression in trade had been absolutely universal, and all nations had suffered alike. As a natural consequence the relations of capital and labour had been of a very uneasy and disturbed character, and both at home and abroad the stage of actual social revolt had been very nearly reached by the unorganised and starving unemployed. In their own trade their experience had been of the most searching kind, but still their position had not been nearly so bad as it was in 1879, which still held its position as being the worst year the Society ever passed through. In order that the two years may be readily compared with each other, the following tabulated statement of the number of members on out-of-work donation in each month of the respective years is given:—

	1879.	1885.		1879.	1885.
January	5675 ..	4090	July	5679 ..	2695
February ..	5800 ..	3243	August	5662 ..	3107
March	6615 ..	3086	September ..	5597 ..	3250
April	6889 ..	2939	October	5755 ..	3565
May	6463 ..	2908	November ..	5493 ..	3554
June	5793 ..	2817	December ..	5028 ..	3626

From this it will be seen that whilst the average unemployed list for 1879 was 5862, it was for 1885 only 3240, and taking the proportion of unemployed to the total membership, it was only 7·05 in December, 1875, as compared with 11·3 in December, 1879. The large number of members on strike during a considerable portion of 1879 must, however, be taken into account in comparing that year with 1885, which, with the exception of the Sunderland dispute, was a comparatively peaceful year; but allowing for this, 1879 was a very much worse year for the Society than 1885. The depressed condition of employment, if, however, it had not actually in 1885 touched the low level of 1879, has since the current year set in been intensified to such an extent that it is questionable whether the present real demand for labour is not quite as restricted as during, to again quote the words of the report, "the worst year the Society ever passed through."

That the question of foreign competition is felt to be a sore point by the trades' union organisations of this country is evidenced by the large share of attention which this matter invariably receives in the reports issued to their members, and Mr. Burnett devotes several pages of his address in attempting to minimise its importance so far as the engineering branches of industry are concerned. "We are," he says, "continually being told of the increasing severity of foreign competition; but if the figures of last year are compared with those of only ten years ago, it will be seen that during the whole of that period our exports of machinery and engines have year by year increased, and bad as 1885 has been, we sent abroad nearly four millions worth of engineering products more than we did in 1876. Nor must it be thought that these figures represent the whole force of the comparison. In 1876 pig iron, which may be taken as largely determining the cost of material used in our trade, sold at £2 7s. 10½d. per ton, while last year the price was £1 12s. 6d. per ton, and nearly all other engineering raw material was relatively as cheap. The quantity of our engineering exports last year must therefore have been enormously in excess of any previous years in our history, except the three years immediately preceding." Mr. Burnett, however, cannot conceal that even he looks to the future with very considerable apprehension, and he admits that "it cannot be disputed that some day or other foreign competition may seriously affect our trade," but he pleads that the figures he has quoted "prove that the time has not come yet." As the probable means by which this foreign competition will be developed, Mr. Burnett points out that "every engine and machine we construct for abroad takes with it its lesson, and becomes the pattern to the foreign capitalist and workman. Each nation is ambitious to make all it can for itself, and is not slow to use its imitative faculties in reproducing the goods they buy from us. This element becomes stronger and stronger year by year, and our greatest efforts but tend to bring nearer the day of more perfect mechanical equality among the nations of the earth. As yet, however, we more than maintain our lead of all competitors, in spite of the disadvantages against which we have to contend. Foreign engineers work for less wages and toil much longer hours. It does not necessarily follow that longer hours mean more or better work, but the sixty to seventy hours per week of foreign labour weights us heavily as workmen, and is one of the most constant arguments used against us by our employers." Notwithstanding that so much is said about "the brotherhood of the human family," Mr. Burnett evidently has no hope that this will have much influence in bringing about a perfect labour equality as well as the "perfect mechanical equality amongst nations," to which he has referred; and although the "one remedy" for the present over-crowded condition of the labour market in this country is "the reduction of hours and the limitation of overtime," with "such standards of a week's work as the foreigners set up," he sees "little hope of an eight hours' day just yet."

Touching upon the depression in the shipbuilding trade, which Mr. Burnett admits has been "terrible," he quotes from a North-country paper the statistics as to foreign shipbuilding which have previously, for a similar purpose, done service in the report of the Steam Engine Makers' Society, and draws from these "the consoling reflection that our supremacy in this line of business is practically undisputed." The members of the Society have, however, he adds, "suffered terribly from the state of the marine trade, and in nearly all the shipbuilding centres wages have been reduced. Under such circumstances it was felt that resistance would be useless, and we have not, therefore been burdened with any strike of importance. The long protracted dispute at Sunderland continued all through the year, but was gradually drawn to a close in December, although the deplorable state of trade in that locality still leaves many of our members out of work."

The action of the employers in the machine and tool districts with regard to wages is next dealt with. "The Employers' Association," says Mr. Burnett, "is collecting information, and systematically tabulating it, as to the rate of wages paid in every part of the country, with a view to establish uniformity by levelling wages downwards to the lowest point. So far as we are concerned, we must pursue an exactly opposite policy. We know which are our lowest paid districts, and must make an effort to get them up towards the higher level. How is this to be done? There is but one method which we can hope to make effective. Our lowest paid districts are those in which organisation is weakest, and in which our Society has, consequently, least power. Here we have at once cause and effect. It is evident, therefore, that to raise wages in the lower paid districts the work of organisation must be vigorously taken in hand, and all men in the trade who are eligible must be drawn into the Society. This may require some hard work in the districts concerned, and may even cause some expense to the Society, but it must be done. If not, it means that these districts will themselves fall lower in the scale of remuneration, and will every day become a greater source of danger to the higher paid parts of the country, by reason of the unceasing competition which goes on among employers. It is for branches and district committees to realise fully the importance of the issue now so clearly at stake, and they may rely upon the assistance of the Executive if they enter resolutely upon a course of active propaganda work in the interest of the Society and the trade at large."

What the actual experience of the year has been to the Society may be gathered from a brief summary of the results of its operations during the twelve months. First, as regards the number of members, there has been a slight increase. At the close of 1884 the Society numbered 430 branches; during 1885 additional ones were opened at Newcastle-on-Tyne, Long Ditton, Woolwich, Gateshead, Redfern (Australia) and Eagle Rock (United States), but branches had been closed at Harecastle, Luton, and Milwaukie and St. Louis (United States), leaving a total of 432 branches at the close of the year. These branches are distributed throughout various parts of the world as follows:—In England, 308; Scotland, 42; Ireland, 14; Australia, 11; New Zealand, 3; Queensland, 2; East Indies, 1; Malta, 1; Canada, 7; United States, 42; and France, 1. The number of members has gone up from 50,681 in 1884 to 51,689 at the close of 1885; but this small increase is attributed largely to the improvements in the admission rule which have been made during the year. As regards the financial position of the Society, however, it has lost ground very seriously. The total income for the year amounted to the large sum of £144,639; but this was £12,845 less than the income raised in 1884. Of this sum £136,513 was raised in contributions, fines, and levies, and £3088 in proposition and entrance fees. Turning to the expenditure side of the balance sheet, the members are, to quote the words of Mr. Burnett, "confronted with an array of figures truly formidable as compared with every other year in their history save 1879." During last year the Society spent no less than £188,277 on the various benefits and other expenses. The dulness of trade had, as a matter of course, thrown thousands of their members out of work, and the unemployed benefit had consequently been very heavy, absorbing no less a sum than £76,949, which was an increase of £14,638 on the previous year. The contingent or dispute outlay had, however, been only small, amounting to no more than £1366, but under another name, "assistance to our own trade," £9427 had been expended, and this went almost entirely to the support of the Sunderland strike which began in 1883. Sick benefit cost £29,775, an increase of £1798 on the previous year, and the highest expenditure which this benefit has yet entailed on the Society. Funeral benefit rose to £8689, an advance of £436 on the previous year, and accident benefit cost £1800, which was just about the average. The superannuation benefit, the seriously increasing cost of which has necessitated a special consideration of the matter and a revision of the rules during the past year, showed the usual annual increase, going up from £30,519 in 1884 to £32,608 in 1885. With regard to this increase, Mr. Burnett points out that the alterations of the superannuation rule have not yet had time to take effect, but it was already becoming rapidly evident that their liability under this head was still so serious, that whatever the state of trade might be their funds would never again recover themselves with the same marvellous rapidity as they used to do. The applications for "benevolent grants" had also been very numerous, and under this head, the outlay, which had amounted to £4160, has been heavier than in any year save 1879. The working expenses of the Society have amounted to £22,166, and the cost of the delegate meeting held during the year for the revision of the rules amounted to no less a sum than £7486. Mr. Burnett, in concluding his address, thus sums up the general position of the Society:—"We have 432 branches, with an aggregate muster roll of 51,689 members scattered over the various quarters of the globe. Our total income for the year was £144,639, and our expenditure £188,277—a balance of outlay over income of £43,638, which, deducted from our 1884 balance of £162,768, leaves us with an accumulated fund in December, 1885, of £119,130, or £2 6s. 1d. per member. Thus two years of bad trade coming upon us suddenly, and before we had recovered from the terrible crisis of 1878-9, has reduced our funds to the lowest value per member they have reached since 1869. But these figures should not depress us. As compared with some kindred organisations we have come well through our troubles, and are able to look the future hopefully in the face, feeling confident in the loyalty of our members and our consequent ability to maintain our position. That the national trade will again revive is certain. In the meantime what we have to do is to concentrate ourselves as much as possible upon the work of organisation in the districts where it is most needed."

LETTERS TO THE EDITOR.

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

FORTY KNOTS AN HOUR.

SIR,—The exposition of the law by which the power must be determined that will be necessary to propel a vessel of light structure at a speed of forty knots an hour in the open sea, though constituting a part of the paper which I had lately the honour of reading before the Junior Engineering Society—and of which my follow student Mr. Paulson has, I observe, sent you a summary—did not constitute the main topic dealt with by the paper, but was rather a development incidental to the discussion of the larger question. My design was to show that as all armour is now penetrable by existing guns even at considerable ranges, the days for armour, whether on men or ships, have gone by, and that this momentous fact rightly interpreted and utilised will insure to us the continued sovereignty of the seas, as it renders merchant vessels as effective, or nearly so, for every purpose of defence or aggression as war vessels. And whereas in force of armourclads foreign nations are collectively twice as strong as us, we, on the contrary, in the force of commercial steam marine, are more than twice as strong as all the other nations of the world put together. In the case of mercantile vessels to be hereafter built there would be no difficulty, Sir N. Barnaby informs us, in inducing the owners to place the machinery below the water line, and to employ other expedients of military safety; and I proposed that a new class of light mail vessels should be created capable of reaching a speed of forty knots an hour at the measured mile, with an armament of a single swivelling steam gun of small size capable of delivering a continuous stream of balls, and a single great rocket-torpedo gun which would send ricochetting rocket-projectiles through long ranges, guided in the horizontal plane by the surface of the water. These projectiles, which on striking any object would ignite by percussion a large volume of explosive material, would be fired from guns of large bore but light scantling, with a light charge of powder, so as to impart sufficient velocity at the beginning of the flight to obviate waste by slip and to confer accuracy of direction. But as the main part of the propulsive effect would be due to the rocket composition which would continue operative throughout the flight, a very large range and great penetrating power are reconcileable with a large gun and moderate charge, and such guns the lightest class of vessels would be able to carry without difficulty. A vessel of our commercial navy, if fitted with a single gun of this character, would be converted into a formidable military instrument, and I indicated a mode of casting in wrought iron or steel by the Rodman process such guns as would be needed, according to a new method which enables castings to be made in those materials, without any of that honeycombing which has heretofore constituted an insurmountable objection. By this method guns even of the largest size could be produced at a very inconsiderable cost.

Such then are the main points of my suggestion for reinforcing our existing navy by an auxiliary navy, which would have much the same relation to the Royal Navy that the Volunteers have to the line. That such an auxiliary navy rightly handled would confer great additional naval strength it needs no argument to show, and that it would be cheap as well as strong is equally obvious. In times of peace it would be earning its living by pursuing its commercial vocation. In time of war it would to any desired extent be made available for the uses of Government on pre-arranged terms. By such a utilisation of our advantages we should, I submit, acquire surely and promptly the maximum aggregate of efficient naval force at the minimum of expense.

Student, College of Practical Engineering, C. F. HURST.
Chiswick, May 10th.

PILE DRIVING.

SIR,—Seeing that your correspondents on this subject have retired from the discussion without solving the exercise in dynamics preliminary to the subject, proposed by Prof. Greenhill—one of them confessedly from inability to do so—it remains for mathematicians to infer that engineers are not sufficiently well acquainted with dynamics to be able to answer the questions proposed. I therefore beg to offer the solutions required. For convenience of reference I would ask you to reprint the theorem, which reads as follows:—

"An inelastic pile of w pounds is driven vertically a feet into the ground by n blows of a hammer of W pounds falling h feet. Prove that $\frac{n\,W^2}{W+w}\,\frac{h}{a}$ pounds superposed on the pile in addition to W would drive it down slowly, supposing the resistance uniform. If the pile is crushed x feet by each blow, x being a small fraction, the mean pressure exerted by the hammer during the blow is $\frac{W\,w}{W+w}\,\frac{h}{x}$ pounds, and each blow lasts $\frac{x}{h}$ of the time of falling of the hammer.

"If, however, the resistance of the ground is proportional to the penetration of the pile, then $\frac{2\,n\,W^2}{W+w}\,\frac{h}{a}$ pounds must be gradually superposed to drive the pile down slowly."

Firstly, let R be the supposed uniform resistance; then since $\frac{a}{n}$ is the penetration of the pile at every blow, $R\frac{a}{n}$ is the work done against this resistance at every blow. Again, if V be the velocity of the hammer at the commencement, and v the velocity of both hammer and pile at the end of impact, we must have $v\,\frac{W+w}{g} = \frac{W}{g}\,V$; or $v\,(W+w) = W\,V$; from which $v = \frac{W\,V}{W+w}$. At the end of impact we thus have the ram and pile, weighing $W+w$ pounds, travelling with a velocity v; and therefore capable of giving out work against the resistance of the ground to the amount $\frac{(W+w)\,v^2}{2\,g}$. So that we have

$$R\frac{a}{n} = \frac{(W+w)\,v^2}{2\,g}.$$

$$\text{But } \frac{v^2}{2g} = \left(\frac{W\,V}{W+w}\right)^2 \frac{1}{2\,g} = \left(\frac{W}{W+w}\right)^2 \frac{V^2}{2\,g} = \left(\frac{W}{W+w}\right)^2 h.$$

$$\text{Hence } R\,\frac{a}{n} = \frac{(W+w)\,W^2\,h}{(W+w)^2} = \frac{W^2\,h}{W+w} \text{ or } R = \frac{n\,W^2\,h}{(W+w)\,a};$$ *i.e.*, if this load be superposed on the pile it will equilibrate the resistance, and if W be added, it will drive the pile slowly down.

Secondly, if the pile be crushed x feet at every blow, this crushing is effected by the fall of the hammer supplying a gradually increasing force, which both crushes the head and changes the momen um of the pile from o to $\frac{w\,v}{g}$. In doing this the hammer's velocity relatively to the pile falls gradually from V to o, so that the mean velocity with which the hammer describes the space x is $\frac{V}{2}$; the time required being, therefore, $\frac{2\,x}{V}$.

Now since force × time it acts = momentum produced during that time, the mean pressure exerted by the hammer $\times \frac{2\,x}{V} = \frac{w\,v}{g}$, or $M\,P = \frac{w\,V\,v}{2\,g\,x}$; but we have already seen that $v = \frac{W\,V}{W+w}$. Hence $M\,P = \frac{w\,V \times W\,V}{2\,g\,x\,(W+w)} = \frac{W\,w}{W+w}\,\frac{V^2}{2\,g\,x}$.

But $\frac{V^2}{2\,g} = h$; $\therefore$ $MP = \frac{W\,w}{W+w}\,\frac{h}{x}$.

Time of blow $= \frac{2\,x}{V}$;

Time of fall of hammer $= \frac{2\,h}{V}$;

Time of blow $= \frac{x}{h} \times$ time of fall of ram.

Thirdly, if the resistance is proportional to the penetration, and R be its value at the end of a blow, its mean value will be $\frac{R}{2}$, which must be equal, $\frac{n\,W^2\,h}{(W+w)\,a}$ as before, or $R = \frac{2\,n\,W^2\,h}{(W+w)\,a}$.

Hence this number of pounds is equal to the resistance at the end of a blow, so that it must be gradually superposed to drive the pile down. JOHN T. NICOLSON,
Care of R. and W. Hawthorn, Leslie, and Co.
St. Peter's Works, May 10th.

HEATING FEED-WATER AT SEA.

SIR,—I have read Messrs. G. and J. Weir's letter in your issue of 7th inst. with much interest, and agree with them that your article on the above subject is the first which has gone so simply, clearly, and in such a detailed manner into a most important matter. Referring to their letter, the heaters working in steam space are anything but a novelty, and about coeval with the steam boiler itself. Their great defect is that in a very short time they become solid with the various substances held in solution in the feed-water, but which in this class of heater rapidly and firmly adhere to it, and render it both inoperative and a source of danger through being in a position where it is inaccessible.

Messrs. Weir have done good service in the cause of steam, and in their long continued endeavours to economise fuel in raising and maintaining steam in boilers, and it is needless in any way to question their statements. With them I sincerely hope that Mr. Brock will confer what would be an inestimable favour on those interested in this subject, by giving detailed results of his exhaustive experiments as to feed heaters, and the results obtained from them in the last two years. Personally I can only say that I have always, in the conduct of my business in carrying out extensive repairs on large and valuable boilers, looked on the intense strains, due to unequal expansion caused by the difference of temperature that boilers are subjected to when raising steam, and afterwards by the very great difference between the heat of the water in the boiler and that entering it as feed-water, as a most serious evil, and one to which many repairs are due, and much waste of fuel, increasing with the pressure and consequent difference of temperatures. My heater was designed to save the great annoyance and expense due to these expansive strains, and was found by those who purchased and used them to save fuel also, a thing that I had never represented or impressed upon them.

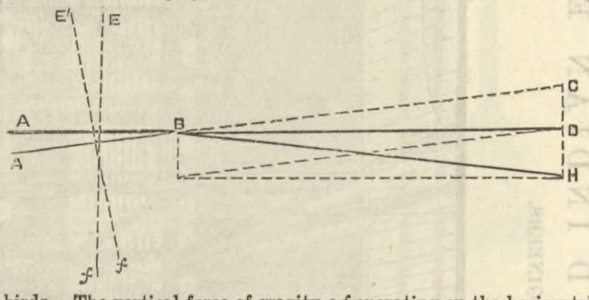
This saving does, as you truly remark, seem incredible, but an eminent namesake, who is known to all users of iron and steel for the valuable tests he has carried out for many years, has chosen for his motto the remarkable words, "Facts, not opinions." I will, in imitation of him, collate a few results and put them before you in a few days. They have been carefully and accurately ascertained, and while I am not prepared to enter into any discussion, having no time for it, shall be most happy to give up my authorities to you, and if they are willing to take the trouble of correspondence, you will have matter from me which cannot be disputed, though perhaps contrary to theory, backed up by the vouchers of those who have benefitted by my system, and to whom I am indebted for my facts. JOHN KIRKALDY.
40, West India Dock-road, London,
May 11th.

THE PROBLEM OF FLIGHT.

SIR,—(1) A plane, when acting on elastic fluids, such as atmospheric air, is subject to work in one, or both, of two ways only, viz., in any direction in its own plane, or at right angles to its surfaces. (2) Forces in the plane, or normal to it, are not resolved by the plane, but work in those directions to their full value, independently of each other. (3) Forces in neither of those two directions—*i.e.*, in the plane, or normal to it—are resolved therein by the plane. (4) Any number of forces from as many different directions simultaneously operative upon the plane, act in the resultant of one force, in one direction, and this resultant, if not already in the plane, or normal to it, is resolved therein by the plane. (5) A plane, therefore, can be subject to work on air in three ways: (1) in its own plane, (2) at right angles to its surfaces, (3) in both of these directions. (6) The work done by the force normal to the plane is compressing air; that of the other is overcoming surface, or skin, frictional resistance. (7) Forces operative upon the plane, not in it, nor normal to it, are resolved in the same ratio that the direction of the force bears to the other directions.

It thus seems evident that a plane refuses to do work on material subject to the law of fluid pressures, excepting in one, or both, of the two above-named ways.

This characteristic of a plane is productive of astonishing consequences when employed as a mechanical device by the soaring



birds. The vertical force of gravity $e\,f$ operating on the horizontal plane A B would not be resolved by it, but would drive the plane in its direction to its full value, when a slight horizontal force would move it to D, and it would pass on the resultant to H. It would not be elevated at any time, but would simply have horizontal motion added to its vertical motion. The force developed in the air by the fall would be many times that required to overcome atmospheric friction in the horizontal motion. This would not be soaring, as the plane would soon strike the earth.

If we tilt the plane 18 deg., or 1 in 5, to the position A^1 B, the gravitating force is resolved by the plane (3 and 7) into two forces, one of which is normal to the plane on $e^1 f^1$, and the other in the plane in the direction B A^1, four-fifths of the total value of the force goes over 18 deg., and one-fifth of it 108 deg. If motion towards A^1 be resisted at the point of entire prevention, the total gravity will be normal to the plane on the line $e^1 f^1$, and one-fifth of the total will be required to stop the motion. The same amount of force required to carry A B to D will now carry it to C, and the resultant B D is the horizontal one of soaring. The total force developed normal to the plane must now supply one-fifth of its amount to resist the force of an equal amount deflected to the plane, besides furnishing the trifling quantity needed in the lateral motion, which it is entirely competent to do, and still leave a large surplus.

As the plane is now elevated as fast as it falls, it would seem that a body in falling could develop far more force than was required to lift it through the same perpendicular height. It would certainly seem that the weight was lifted against gravity, as fast as it fell with gravity, and a great surplus left over! In order to maintain this appearance of impossibility, it is necessary to entertain a fallacy of very respectable proportions. The vertical force on $e\,f$ has been thrown over 18 deg. and 108 deg. by the plane. Before resolution, as A B, it acted in $e\,f$. It now acts in $e^1 f^1$. Its former vertical has been vacated and re-located on a line removed 18 deg. So far as work being done on the plane is concerned, $e\,f$ is non-existent. A^1 B has changed the horizon of the world to suit its own purposes, and a soaring bird's horizontal is not the level of the sea but the slant of its own wings. Not one atom of force draws a bird towards the centre of the earth in the act of soaring. In the case we have supposed its vertical would pass some twelve hundred miles one side of that point. Still, although the horizon has been changed, it is reasoned about as if it were still on the level of the sea. This is inadmissible. If gravity has abandoned $e\,f$ and gone over to $e^1 f^1$, there is where it is to be found at work, and it must be looked for where it is instead of where it is not. To rightly estimate this case, two standards of horizontals must be entertained—the level of the sea, and the slant of the wings of the birds. The plane in the lateral motion must fall continually from the bird's level to keep on our horizontal, and the resultant B H is the bird's level line.

I have repeatedly witnessed the flight of frigate birds in calm air wherein the vertical was thrown over at least 20 deg., and have constructed numberless effigies which deflected at 15 deg., even under the enormous disadvantages those devices laboured under. I have persistently held that this peculiarity of a plane exhibited in the resolution of forces made of the gravitating force a continuous motive power. It is not confined to the birds.

Chicago, April 3rd. I. LANCASTER.

THE BURSTING OF A 43-TON GUN ON BOARD H.M.S. COLLINGWOOD.

SIR,—The leading article on the above subject in your last issue, although reassuring in its tone, is hardly calculated to restore complete confidence in our heavy breech-loading guns. The Active Committee did, it is true, recommend that some patterns should be strengthened in the chase, but if the members relied on the same data as they did when limiting the charge of the 12in. Mark II.—the pattern which has just failed—what is to guarantee us against the same disastrous result when the strengthened guns are fired with their larger powder charges? At the time when the Active Committee was sitting, you published an article—6th February, 1885—on a lecture given by Mr. Anderson at the Society of Arts, in which you compared a curve of pressures calculated by him with the official one. I read in a letter to the *Times* by no less an authority than Col. Moncrieff, C.B., that Mr. Anderson has endeavoured to persuade the War-office to test the theory propounded by him, and which is endorsed by Col. Moncrieff, but has hitherto failed. The difference between the official curve of pressures and that advanced by him is, as you showed, very great; and from the fact that we have now several guns failing at the point where the curves diverge most, surely it is time that some steps be taken to test the correctness of Mr. Anderson's conclusions.

London, May 13th. ENGLISHMAN.

RAILWAY MATTERS.

THE International Conference for establishing a uniform technical railway system was opened at Berne on Monday last.

THE Railway and Canal Traffic Bill passed its second reading in the House of Commons on the 6th inst., after a comparatively brief discussion.

A SECTION of thirty miles of railway, known as the Molinsville-Te-Awhi line, New Zealand, between Auckland and the Hot Lakes, has been opened.

MR. F. H. CHEESEWRIGHT, A.M.I.C.E., has been appointed chief engineer to the Great Southern Railway of Western Australia for the West Australian Land Company. The line will be commenced in October next.

THE running of the Blackpool electric cars during the heavy Easter traffic was completely successful. The line is two miles in length. On Good Friday, over 5700 passengers were carried; on the Saturday, over 4000; on Easter Monday, over 6000.

IN our impression of May 7th, and in this column, we stated that the Manchester, Sheffield, and Lincolnshire total of goods in and out of Sheffield was, in the year 1870, 52,604 tons, and in 1884, 18,006 tons. These figures, we understand, are not correct, as the total tonnage of goods, in and out of Sheffield, exclusive of coal and canal traffic, for 1870 was 346,993, and in 1884, 512,915 tons.

IT is reported that: "The completion and opening of the Moray Firth Coast Railway were celebrated in fitting fashion a fortnight ago all along the coast from Portsoy to Elgin. The directors and officials of the Great North of Scotland Railway, and a number of friends, who travelled from Aberdeen by special train, were presented at Cullen and Port Gordon with congratulatory addresses, and on arrival at Elgin were met at the station by a procession and assemblage of some thousands, headed by the Provost." A few days later a fine bridge over the Thames, a new London station, and a new railway to Gravesend were opened the same day, without either celebration or addresses of any kind.

WE are asked to state with reference to our recent notice of the Mersey Tunnel Railway, the stations on that line were covered with Helliwell's system of glazing without putty, and zinc roofing without external fastenings or solder. Mr. Helliwell is also about to cover the roof and galleries of the National Agricultural Hall at Addison-road with his glazing and zinc roofing. The area covered will be about 145,000 square feet, and at the Blackburn new station, for the Lancashire and Yorkshire Railway Company, he is putting on 103,000 square feet of zinc and glass roofing. The new roof for the Gravesend extension of the London, Chatham, and Dover Railway, was also covered about two months ago.

RUMOURS are again widely circulated with regard to the intention of the Great Western to have a footing in Wales for rail making. Some weeks ago Cyfarthfa was named, then Plymouth, but the place now selected is confidently stated to be Aberaman, in the Aberdare Valley, and in close proximity to the residence of Sir George Elliott. Sir George's vigorous opposition to the Great Western Railway suggested rather an opposition docks than a neighbouring ironworks, but the amenities of great men are beyond the ken of ordinary individuals. If Aberaman has been selected, it is the site only that is considered, and its being the centre of a coal district. Close at hand is Fforchaman, a fine colliery of the Powell Duffreyn, and the Dare Valley, again, which has a large coal traffic to London. The iron plant is, of course, obsolete.

A REPORT by Major Marindin has been issued on the accident which occurred on the 23rd February near Chester, on the London and North-Western Railway, when, as the 3.47 p.m. passenger train from Crewe to Chester—consisting of engine and tender, bullion van, one third-class, one lavatory composite, and one long composite carriages and brake van—was about to enter Christleton Tunnel, two miles from Chester, the third-class carriage left the rails. The train was stopped upon the whistle on the engine being sounded by the pulling of the communication cord, but not until it had run some 1300 yards from the point where the first pair of wheels left the rails. The whole of the wheels of the third-class carriage were then off, but none of the other vehicles in the train left the rails. No satisfactory explanation of the accident is given, and Major Marindin has the courage to admit that he does not know the cause.

THE American railway accidents during March are classed as to their nature and causes as follows by the *Railroad Gazette*:—Collisions: Rear, 16; butting, 5; crossing, 1—22. Derailments: Broken rail, 6; broken rail joint, 1; broken switch rod, 1; broken bridge, 3; spreading of rails, 6; broken wheel, 1; broken axle, 7; broken brake beam, 1; accidental obstruction, 1; cattle on track, 2; wash-out, 1; land slide, 7; snow or ice, 1; misplaced switch, 2; purposely misplaced switch, 1; rail removed purposely, 3; malicious obstruction, 2; unexplained, 9—55. Other accidents: broken parallel rod, 2; overhead bridge, 1; broken axle not causing derailment, 1—4. Total number of accidents, 81. Of the collisions, 3 were caused by trains breaking in two, 2 by misplaced switches, and 1 each by fog and by cars blown out upon the siding by high winds. One of the broken bridges recorded failed on account of the weakening of its abutments by a freshet. The other two were wooden trestle bridges.

A MOST unfortunate accident has occurred to Mr. Alfred C. Hill, general manager of the Clay-lane Iron Company, and President of the Cleveland Institution of Engineers. A few days since, Mr. Hill, with two other gentlemen, desired to go from the works down to the wharf belonging thereto. With this object they got on to a shunting engine, the driver whereof also accompanied them. It is believed that Mr. Hill had previously telephoned to the wharf to send a locomotive from thence to fetch him, but received no conclusive answer that this would be done. Consequently he started off. The line is a single one, and when about half way to the wharf the other engine was seen approaching at a rapid rate, and a collision appeared inevitable. All jumped off except Mr. Hill, who stuck to the engine in his desire to save it. When the collision took place he was thrown violently against the fire-box and weatherboard and sustained serious cuts, bruises, and scalds, besides a severe shock to the system. It is not doubted but that Mr. Hill will eventually recover, and it is hoped without permanent disfigurement. Meanwhile universal and profound sympathy is expressed for him as one of the ablest and best-known engineers in the North of England.

ON Monday the Chatham and Dover Railway Company's new bridge over the Thames at Blackfriars, and St. Paul's station, and the Gravesend branch—of which we have given full descriptions—were opened for traffic. The new station will be very extensively used. Of the main-line service twenty-five trains, mainly for the short runs down as far as Beckenham or Bromley, start from this point, and the remaining forty-eight call here after leaving Holborn Viaduct and Ludgate Hill. In the same way, of the sixty-five up-trains twelve stop at St. Paul's station, and the remaining fifty-three run on to Holborn, in the majority of cases stopping at Ludgate. The Victoria trains still run into Ludgate, and thence through Snow Hill on to the Metropolitan system. The new Gravesend service is a liberal one, consisting of fourteen trains, which run about every hour, commencing at 7.18 a.m. A feature of the service are the four cheap Gravesend trains, the first of which leaves St. Paul's at 10.3 a.m., reaching the river at 11.10 a.m. The last train for Gravesend does not leave London until 11.13 p.m., and reaches its terminus at 12.30, whilst the last train up to London leaves at 10.30 p.m. The Dover Continental boat express, which leaves Holborn at 7.55 p.m., now misses Ludgate, calling at St. Paul's instead, and the same applies to the 8.25 p.m. Queenboro' boat express. In the morning also the 7·55 from Holborn passes Ludgate and calls at St. Paul's.

NOTES AND MEMORANDA.

A CONTRACT has been let for caulking the seams of the upper deck of the Great Eastern. The seams are altogether twenty-two miles in length.

THE production of spiegel and ferro-manganese in the United States in 1885 was 30,955 long tons, as compared with 30,262 tons in 1884. Assuming 40 per cent. manganese as the dividing line between spiegel and ferro-manganese, and that all the ferro-manganese made in the United States was made at the Edgar Thomson Steel Works, the production of spiegel in 1885 would be 23,737 tons, and of ferro 7218 tons.

HERR VOHWINKEL, in Vienna, manufactures a primary battery that is intended to be placed under a carriage driver's seat, and which gives a current of 18 ampère-hours at 36 volts pressure. The cells are inclosed in a wooden box, 23in. by 8in. by 9in., and a switch is fitted to the driver's seat, by which the current can be interrupted. It is stated that there is hardly any local action when the switch is off. The cost of keeping alight three 7-candle lamps for nine hours—after which time the battery has to be re-charged—is stated to be 2s.

"CONSIDERING our present knowledge of the mischief caused in breweries by the innumerable organisms which float in the air, especially in our large towns, the *Brewers' Guardian* remarks that it is somewhat surprising that no enterprising brewer has attempted to establish a pure air brewery. Under such conditions it would seem feasible to preserve beer much longer than at present. It would not be necessary to have the whole of the brewing operations protected from impure air, but only the later ones, that is, subsequent to the sterilisation of the wort, which practically takes place in the copper." We may add that inasmuch as in almost all modern breweries the beer is cooled by exposing it in thin streams to the air, every ton of liquid exposing acres of thin stream to the air, it is remarkable that beer drinkers are not by this time one big mass of microbes, that is if microbes are not bogies.

THE production and value of manganese, manganiferous iron, and argentiferous manganese ores in the United States for 1885 were as follows:—Manganese ores, 23,258 tons; average value per ton, 8·18 dols.; total value, 190,281 dols. Manganese and manganiferous iron ores, 26,495 tons; average value per ton, 7·83 dols.; total value, 207,599 dols. Argentiferous manganese ores, 4263 tons; average value per ton, 10 dols.; total value, 42,630 dols. With manganese ores are included those ores that contain the equivalent of 70 per cent. of binoxide, or 44·25 per cent. of metallic manganese. This is the standard of manganese required by the English chemical works. All ores containing less than this are in this report regarded as manganiferous iron ores, though some of them approaching the standard are used in the manufacture of ferro, and all are used for their manganese. The argentiferous manganese ores are only used for their contents of silver, the manganese, however, serving a useful purpose as a flux.

THE following, on a "New Method for Determining the Specific Gravity of Gases, and for their Analysis," by F. Lux—*Zeit. anal. Chem.*, 25, 3 to 10—is given in the *Journal of the Chemical Society*:—The apparatus, which the author names a baraeometer, consists of an ordinary hydrometer, carrying at its summit a globe of considerable size. It floats in water contained in a glass cylinder, the upper part of which is filled with the gas. The greater the specific gravity of the gas the higher will the float rise. The stem is graduated by using gases of known density. With a globe of 300 c.c. and a stem whose sectional area is 4 square mm., the difference of level for hydrogen and air respectively will be about 93 mm. The cylinder is furnished with stopcocks for passing a constant stream of gas through it, and by connecting several such cylinders in series, with suitable absorption apparatus between them, the alterations in specific gravity consequent on the removal of individual constituents of a mixed gas can be observed and the original composition thence deduced.

THE *Milling Engineer* gives the following on the cost of producing flour:—We are enabled to give the record of a week's run in the half of the Pillsbury "A" mill which is driven by steam power. The following are the figures for the run of the week ending January 30th, 1886, showing the performance of the compound engine driving one half of the Pillsbury "A" mill. Number of barrels of flour made, 15,768; number of pounds of coal burned, 260,553; number of pounds of coal per barrel of flour, 16·52; average steam pressure, 83 lb.; average receiver pressure, 11 lb.; average vacuum, 25in.: temperature of overflow, 108 deg.; average indicated horse power, 986. The average daily capacity of the one half of the mill driven by the engine was 2628 barrels, requiring an average of ·375-horse power per barrel of daily capacity. It is interesting to note that this average of ·375-horse power is almost identical with that required in the Washburn A and C mills, as it indicates nearly to a certainty that the power required to drive a modern built roller mill does not vary far from ·4-horse power per barrel of daily capacity.

THE following, on the "Quantitative Analysis by Electrolysis," by A. Classen and R. Ludwig—*Ber.*, 19, 323 to 327—is given in the *Journal of the Chemical Society*:—The separation of antimony and arsenic can be readily effected provided that the arsenic is present in the pentad condition. The mixture is evaporated to dryness with aqua regia, dissolved in 2 to 3 c.c. of water, an aqueous solution of 1 gram of pure soda is added together with 60 c.c. of aqueous sodium sulphide, prepared as previously described—Abstr., 1885, 932—and the operation conducted in similar manner to the separation of tin and antimony—*loc. cit.* The deposited antimony is free from arsenic. Antimony can be separated from both tin and arsenic in this way, but if an estimation of the tin is also required, the method previously described—*loc. cit.*—must be used. Mercury can be separated from the alkaline earths, chromium, aluminium, nickel, cobalt, iron, manganese, uranium, or cadmium by electrolysis in dilute nitric acid solution for twelve to sixteen hours with a current giving 0·5—1 c.c. of electrolytic gas. The electrolytic estimation of bismuth and its separation from zinc, nickel, cobalt, and uranium, can be effected in a solution containing potassium and ammonium oxalates, by employment of a current so feeble as scarcely to give any formation of electrolytic gas in a voltameter. The metal deposited under these conditions admits of washing.

AT a recent meeting of the Berlin Physical Society, Herr C. Baur described experiments he had made with water-jets, which, issuing from a conically-pointed tube in parabolic curves, were acted upon by certain musical tones, so that, at some distance from the mouth of the tube, they showed a rotation, and that the jet, though broken up into drops behind the apex of the parabola, contracted into a continuous jet. The thinner was the jet the higher must be the tone towards which it was sensitive; the thicker the jet the deeper the tone. Herr Baur had instituted further experiments with water-jets, which he caused to fall on plates. Under certain circumstances there thus arose quite pure tones, which continued as long as the jet hit on the plate. The experiments succeeded best with a Weissmann apparatus, when the jet issued under a pressure of 10 cm. water from a lateral opening of 4 mm. in diameter without tube. Thin window-glass plates and metal plates, which, resting on pedestals, had free movement of vibration, were best suited as receiving-plates. The tone was most certain of occurrence when the node lines of the plates were supported. In the jet itself appeared nodes and ventral segments at some distance from the opening. They were most distinct and regular at its middle; away in the direction of the plates they again became indistinct. If the metal plate and the water, acidified beforehand, were connected with a galvanic cell and a telephone, then no interruption of the current could be recognised during the time of the sounding. The contact of the water-jet with the plate must necessarily, therefore, be continuous. Herr Baur deemed this mode of excitation very well adapted to the purpose of studying the vibrations of plates.

MISCELLANEA.

ON page 355 of our last impression we referred to the testing of the Werribee Viaduct in Australia. We omitted to mention that this viaduct has been constructed and erected by Messrs. Handyside and Co.

MESSRS. C. MITCHELL AND CO. have reprinted from the "Newspaper Press Directory," for 1886, a pamphlet containing a useful collection of information on India and the Colonies, chiefly bearing upon their resources and business capacities.

THE long ropes we referred to in this column last week as weighing about 49 tons were made on Lang's patent crucible steel wire, there being no splice either in the strands or the ropes, and they contained about one and a-half million yards of wire.

THE *Journal of Commerce*, probably the Liverpool paper of that name, though the sheet before us does not say so, contained on the 10th inst. a useful article directing attention to the losses of ships which result from insufficient examination or swinging for compass adjustment.

THE Loan Collection of Japanese Art, at the Society of Arts, in the Adelphi, will remain open during the week ending the 22nd inst., daily, from 10 till 4 o'clock, and from 7.30 to 9.30 p.m. Admission may be obtained on presentation of visiting card. A very complete catalogue of the exhibits has now been prepared.

GREAT progress is being made with the Kalawewa, Ceylon, irrigation works, which have already had a marvellous effect on the face of the country, as well as on the condition of the people. This tank will cost considerably more than the original estimate, but if it benefits the land, as it undoubtedly will, its financial prospects ought to be good.

THE firm of Morewood and Co., Birmingham, Soho, and London, which has been in business for over thirty years, and which succeeded to the trade of the original patentees of galvanised iron, has been converted into a private limited company, with a capital of £250,000, under the style of Morewood and Co., Limited. None of the shares issued are offered to the public.

THE defects in the machinery of the new steel cruiser Phæton, 10, 3550 tons, 5000-horse power, have proved more serious than was at first supposd, and will delay her departure for the Mediterranean station for at least a fortnight. The mercantile marine is supposed not to know what first-class machinery is, but those in it seldom find the machinery a fortnight of repairs worse than they thought.

THE number of unemployed persons in Sydney—says the *Melbourne Argus*, March 24th—has recently become so great that the Government has taken steps to despatch such of them as are willing to go into the country, where they would have no difficulty in obtaining work. It would seem, however, that it is not want of work but want of money without work which affects a good many in Melbourne as elsewhere. Questions as to hours and apprentices are now keeping men idle.

THE Royal Cornwall Polytechnic Society, Falmouth, has just published its annual prize list and regulations for competition. It offers medals and other prizes—some being convertible into money awards—for (1) collections of metallic and other local rocky and other substances; (2) for improvements in mining and metallurgical machinery, engines, boilers, &c.; (3) for essays on prescribed subjects; (4) boat-lowering apparatus and steam fishing vessel; (5) prizes in chemistry and electricity; (6) in fine arts, photography; "Lauder" prize for boys for essay and map of British South Africa, and for shorthand. The secretary is Mr. E. Kitto, Polytechnic Hall, Falmouth.

MR. JAMES BRUNLEES, on whom the Queen conferred the honour of knighthood at Windsor on Saturday, is senior engineer of the Mersey Tunnel Railway. Sir James Brunlees is a native of Kelso, Roxburghshire. He was born in 1816. In the course of his long career he has carried out many important engineering works at home and abroad, among the latter being the well-known Sao Paulo Railway. He is a past president of the Institution of Civil Engineers, a member of the French Society of Civil Engineers, a fellow of the Royal Society of Edinburgh, a member of several learned societies, and a Knight of the Order of the Rose of Brazil, an honour conferred on him by the Emperor in connection with his engineering works in that country.

THE Institution of Mechanical Engineers met at the Rooms of the Institution of Civil Engineers on Thursday and Friday, May 6th and 7th. Papers were read, "On the Distribution of the Wheel Load in Cycles," by Mr. J. Alfred Griffiths; "On the Raising of the Wrecked Steamship Peer of the Realm," by Mr. Thomas W. Wailes; and "On Refrigerating and Ice-making Machinery and Appliances," by Mr. T. B. Lightfoot. With two of these papers we shall deal in an early issue. The anniversary dinner of the Institution took place at the Criterion on Friday evening. Mr. Jeremiah Head, president of the Institution, occupied the chair, and among those present were Sir J. N. Douglass, Mr. Joseph Ruston, Mr. Thomas Hawksley, Mr. Joseph Tomlinson, Mr. Patrick Stirling, Colonel Martindale, Professor Roberts-Austen, and Professor Hughes.

THE new experimental 9·2in. steel wire gun from Elswick has just been tried at the Government proof butts, Woolwich Arsenal, with satisfactory results. The War Department has issued orders for the construction of several more guns of the same description. The Government pressure test for the gun was 65 tons to the square inch. The new weapon weighs 25 tons, and is 33ft. long. The steel wire is coiled round the inner tube at the breech and nearly up to the trunnions, and consists of seventy-eight layers. The wire is made in lengths of 2400 yards, and 20 yards weigh 1 lb. It is flat, and is put on by a specially designed machine by which it is wound under a tension of about 40 tons to the square inch. The lengths are joined together by being brazed and rivetted over a considerable length. After the wire has been put on, a steel jacket is shrunk on over it.

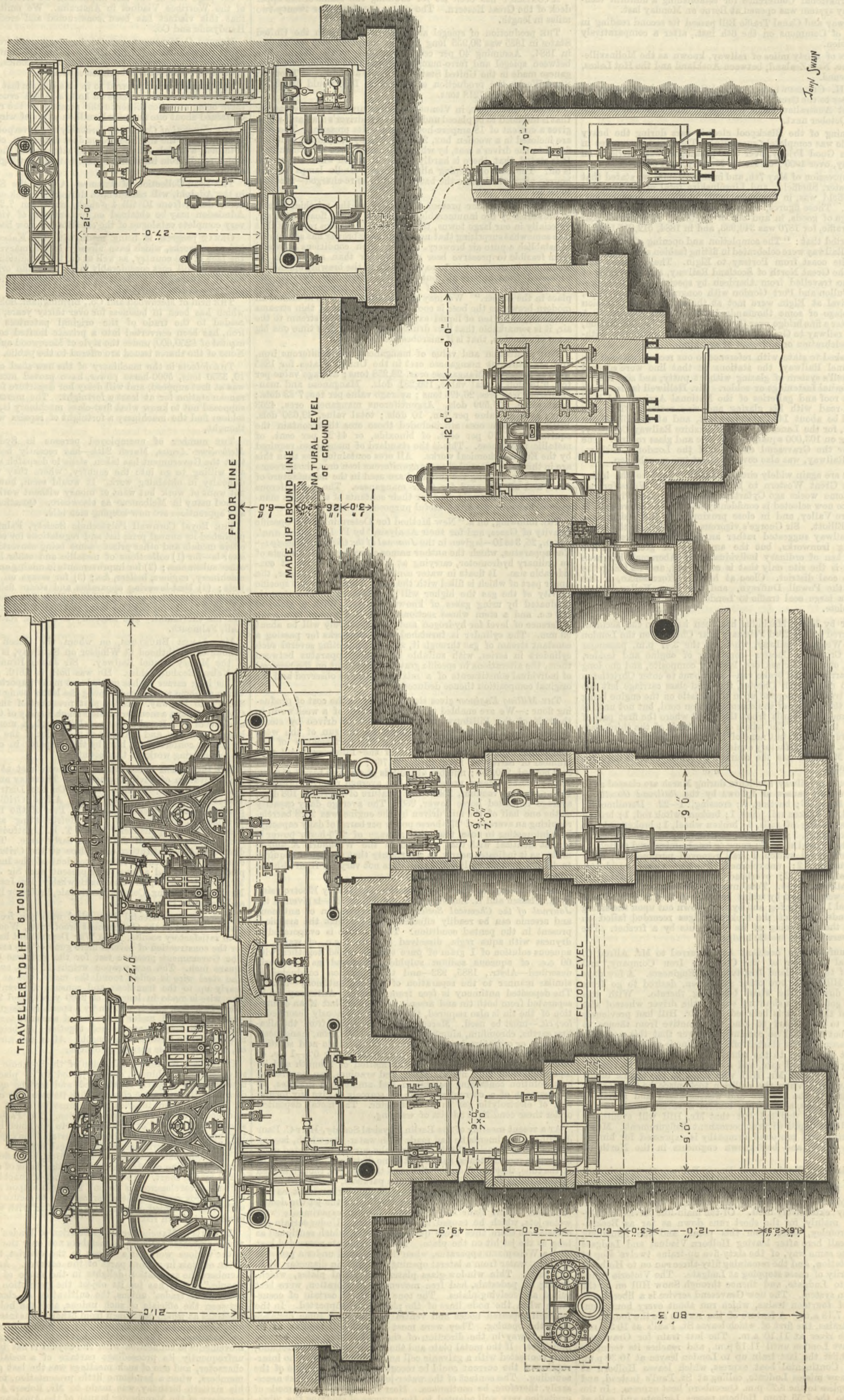
IT has been settled by a decision of the Supreme Court of Pennsylvania that machinery, once adjusted to its place in a factory, is presumably properly constructed, and may be operated without danger to the operative charged with its care. In case of an action for damages from injuries, there must be direct and conclusive evidence to overcome this presumption. The *Philadelphia Record* says, "the meaning of this decision to workmen in this State is that any personal injuries they may sustain from exposed machinery will be at their own risk, so far as legal remedies are concerned. At first sight this may seem a hard thing, but reflection will lead inevitably to the conclusion that no other basis of equity could be found by the court. To make the owner of machinery liable for individual carelessness is to put a premium upon stupidity. The remedies for gross neglect of precautions to secure ordinary safety will never be denied, but the reckless trifler with whirling wheels must run his own risks."

THERE is in Manchester an Association of Trades' Union Officials which embraces amongst its members not only the representatives of the various workmen's unions in the district, but also trades' union officials in various parts of the country. Amongst its own members the association delights in the name of the "Peculiar People," and it has for its object the promotion of the general interests of trades' unions, the cultivation of closer relationship between the officials of such unions, and the holding of regular meetings at which gentlemen from other towns interested in labour questions can have the opportunity of giving or receiving advice and assistance. The association has inaugurated several important movements in connection with the objects it has in view, but not unfrequently its proceedings partake of a social and convivial character, and one of such meetings was the last gathering of the members, when a handsome little presentation, to commemorate his sixtieth birthday, was made to Mr. Robert Austin, the local secretary of the Manchester branch of the Amalgamated Society of Engineers.

THE ROSARIO WATERWORKS.—ENGINES AND PUMPS.

MESSRS. EDWARD EASTON AND CO., WESTMINSTER, ENGINEERS.

(For description see page 379.)



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THE ENGINEER, May 14th, 1886.

TO CORRESPONDENTS.

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T. AND F.—*As yet we have not published any conversion tables but those given in* THE ENGINEER *for Feb. 5th and March 19th.*

A. T. (Birmingham).—*We decline to publish any letters dealing with the claims of individuals to priority of invention.*

J. D.—*When the pitch of a propeller is too sharp the engine cannot exert sufficient push and pull on the crank pins to make the crank shaft revolve at more than a given speed, and the safety valves will blow off although the fires are not urged, and the power of the engine will not be great enough to drive the ship at the required speed because the piston speed will not be great enough. If now the pitch of the propeller is reduced, the resistance to rotation will be reduced, and the engines can run faster and exert a great deal more power, because they can make use of all the steam the boiler will supply.*

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

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

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS, 25, Great George-street, Westminster, S.W.—Tuesday, May 18th, at 8 p.m.: Ordinary meeting. Paper to be read with a view to discussion, "Modern Machine Tools and Workshop Appliances for the Treatment of Heavy Forgings and Castings," by Mr. William W. Hulse, M. Inst. C.E.

CLEVELAND INSTITUTION OF ENGINEERS.—Monday, May 17th, at 8 p.m.; Paper "On Material Economy in House Girders and Permanent Way," by Mr. R. H. Graham, Greenwich.

SOCIETY OF ARTS, John-street, Adelphi, London, W.C.—Monday, May 17th, at 8 p.m.: Cantor Lectures. "Animal Mechanics," by Mr. B. W. Richardson, M.A., M.D., F.R.S. Lecture III.—Some details of results of construction. Tuesday, May 18th, at 8 p.m.: Special Lecture. "Japanese Art Work," by Mr. Ernest Hart. Lecture III.—Japanese picture-books and drawings. Wednesday, May 19th, at 8 p.m.: Twenty-second ordinary meeting. "Watchmaking by Machinery," by Professor Leonard Waldo, D.Sc., of Yale College, U.S.A. Professor J. Norman Lockyer, F.R.S., F.R.A.S., will preside. Friday, May 21st, at 8 p.m.: Indian Section. "Everyday Life of Indian Women," by Captain Richard Carnac Temple. Mr. James Gibbs, C.I.E., will preside. Saturday, May 22nd, at 3 p.m.: Special Lecture. "Electricity," by Professor George Forbes, M.A., F.R.S.E. Lecture VI.—Electrical measurement.

METEOROLOGICAL SOCIETY.—Ordinary meeting at the Institution of Civil Engineers, 25, Great George-street, Westminster, on Wednesday, May 19th, at 7 p.m. Papers: "The Severe Weather of the Past Winter, 1885-86," by Mr. Charles Harding, F.R. Met. Soc. "Description of an Altazimuth Anemometer for Recording the Vertical Angle as well as the Horizontal Direction and Force of the Wind," by Mr. Louis M. Casella. "Earth Temperatures, 1881-1885," by Mr. William Marriott, F.R. Met. Soc. "Note on the After-Glows of 1883-1884," by Mr. Arthur W. Clayden, M.A., F.R. Met. Soc.

THE ENGINEER.

MAY 14, 1886.

WORK AND WAGES.

QUITE one-third of the year has passed without bringing that improvement in trade which optimists assured us toward the end of last season Great Britain was pretty certain to enjoy. It is true that in certain directions there is a little improvement; but the gleam of light only suffices to make the prevailing darkness more intense. It is often pointed out that the volume of our trade has not suffered much diminution as compared with previous years; and that low prices are the worst evil with which commerce has to contend. This statement is not strictly true. But even though it were, our case would still be hard. Those who argue on such a basis that we have little reason to complain as a nation, quite overlook the fact that our population is advancing in numbers by leaps and bounds, and that every year there are more and more mouths to be fed. We rely in this country for our sustenance almost entirely on trade, for agriculture counts for comparatively little. If we cannot keep our works going, then we must starve. It is essential that we should each year produce, or manufacture and sell, more and more of the commodities which the rest of the world wants. That which sufficed for the population of Great Britain ten years ago will not suffice to-day. There are, to put the matter in a sharper light, more working men and women to feed than there were; and this is one reason why so many are out of employment, and such numbers on half-time. It appears to us beyond question that wages must fall to a lower point than they have yet reached before we can produce at a price which will insure the command of markets.

It is very natural that the working man should suggest any remedy for the existing state of affairs rather than a reduction in wages. In recent articles, however, we have shown that the foreign workman is content with a mere pittance as compared with the wages paid in this country. We do not assert that this is right; but, right or wrong, it is a stern, uncompromising fact, and we must deal with it and handle it as one; and it must not be forgotten that the employers of labour abroad are really much poorer, and are content to live much more simply, than the employers of labour at home. In one word, countries with which we have to compete are poorer all round than we are, men and masters alike, and we in England must be content to assimilate our condition in some degree to that of the foreigner. In very many respects, however, we must still be better off. Never in the history of this country were all the necessaries and many of the luxuries of life so cheap as they are now. We do not exaggerate at all when we say that 30s. a week wages now are more than equivalent to 35s. a week ten years ago. It may be worth while, we think, to put this matter in a somewhat different point of view from that in which it is usually presented, especially to the working man. The money paid in wages is really and in itself of no value at all. What the working man gets in return for his toil are commodities, such as bread, and meat, and beer, and tea, and clothes, and so on. The master might pay the man in goods, and the man would be no worse off so long as the bargain was honestly carried out. Indeed, for many years it was the custom in extensive districts to pay in goods, not in money. Abuses crept into the system, and the Truck Act put a stop to it. Let us suppose that in 1875 a workman made an arrangement with his employer that he should receive, instead of money, 30s. worth per week of such goods as he required at current prices. Now such has been the effect of the reduction in the cost of commodities, that year by year the man would have received more and more. For every ten loaves, for instance, which he got in 1875, he would have a dozen now. For every 3 lb. of sugar he would now get about 5 lb., and so on. Thus the man would reap very considerable advantage. If the master refused to continue the arrangement, and offered the man 25s. worth of goods per week instead of 30s. worth, the man would still be better off than he was in 1875. This fact is continually overlooked by the men. To them a sovereign is a sovereign. They are oblivious to the fact that the value of the sovereign as expressed in terms of purchasing power is constantly changing; and that of late years the change has always run in one direction; that is to say, the value of money has continually augmented. A considerable reduction of wages, therefore, does not in any way represent a considerable reduction in the power of buying what the wage-earning classes want. Of course it would be a very good thing if it were possible for the artisan and the capitalist to go on increasing in wealth and in the power of purchasing luxuries and comforts; but this cannot be while we have the foreigner at our doors. Indeed, if we ask why it is that we can buy things so cheaply, the answer is that things are cheap because foreigners are content to supply us with them at a low price. We constantly hear it said, "if only French and German and Belgian and other folk would insist on getting higher wages, we should be much better off in this country." Such a statement is fallacious. The effect of a rise of wages abroad would be a rise in prices at home, which would leave the English working man no better off than he is now.

When competition is keen, high wages tell disastrously against the working man. The capitalist is stimulated to the last degree to do without him. The result is that machinery is more and more used, and hand labour dispensed with in like proportion. It is all a question of cost. If the man is cheaper than the machine he will be employed; if he is not, then he will go idle. The argument in daily use, that the employer is living lapped in luxury while the working man leads a wretched life, deals with questions entirely beyond the control of either the employer or the employed. If the former could divide with his *employés* the whole of his profits he would not enrich them. Let us suppose, for example, that a man employs 200 hands, and makes a clear profit of £1000 a year. He is in the present day an exceptionally lucky man if he does this. If, however, the whole £1000 were divided among the men, it would only give them £5 per annum each, or 1s. 11d. per week. That is to say, the man who before was paid 30s., would now receive 31s. 11d., while the employer would get no return at all for his money invested in the business, or for his own time, talent, and skill. In point of fact, the proportion received by the master only appears to be large because it goes into one pocket; divide it among many, and it becomes evanescent. On the other hand, and for the same reasons, a small reduction in wages, amounting to very little indeed per man, may make all the difference between carrying on a concern at a profit or at a dead loss. In one sense, it may be proved that in many concerns the men actually are paid a considerable sum more than they earn. Thus, for example, a shaft is put in a lathe and turned. The operation takes a week. The turner receives 30s. The shaft is worth £5 more after it was turned than it was before. How much of this has been earned by the man, and how much by the lathe? When it is asserted, as we are sorry to say it sometimes is asserted, that the master runs away with the value of the men's work, it is entirely forgotten that in very many cases the man not only gets the full value for the work he has done, but a large proportion of the value of the work done by the tools and machinery belonging to his master as well. It is right that the truth should be put plainly on this point. It is often forgotten. It is because it is forgotten that we seldom or never hear of a co-operative factory succeeding. In such concerns there are no masters to run away with the men's profits; but we cannot name an instance in which such undertakings were carried on at all, and in which the workmen were better off in regard to wages than they would have been even in the hands of a demon capitalist.

However the relations of labour and capital may be studied, the broad fact remains that a very large number of men are now out of work, and that there is no immediate prospect that they will get it. The only chance for them is that we should be able to sell more goods. More cotton, and iron, and steel, and engines, and machinery; and this cannot at all be done unless we are content to accept lower prices. Whether we are or are not, rests at this moment entirely in the hands of the working man. If he will consent to regard the sovereign as being worth much more now than it was ten years ago, he will soon get employment. If he is content to accept 20s. instead of 25s., seeing that "things are so cheap," then there will be an increase of trade and plenty of work. So long as he holds out for wages which are very much higher virtually than those of any other nation, so long must the British workman remain content to work half-time, and carry on a deadly fight with the wolf at his door. Circumstances may be evil, but this does not alter the fact that they are too strong just now for the working men and the capitalists of Great Britain together.

STEEL SHIPS.

IT is now just ten years since the steel manufacturers of this country succeeded in producing a material suitable for the purposes of the shipbuilder and marine engineer. Previous to that time many attempts had been made, both in Royal and private shipyards, to employ steel in the construction of ships; but the results were not so generally satisfactory as to encourage further developments in that direction. The steel then being made was variable in its qualities; so much so that angle bars which were very ductile at one extremity would sometimes be exceedingly brittle at the other. The behaviour of the material was, indeed, very erratic and unsatisfactory. Some plates and bars would show the best qualities of tenacity and ductility, while others from the same batch would evince the possession of the several characteristics of hard tool steel. After much labour had been expended upon a steel plate, and when it was rivetted in place, it would suddenly become fractured without any warning, and from no assignable cause, except, perhaps, change of temperature. The Admiralty were the principal users of steel in shipbuilding at that time; but the employment was limited to deck flats, stringers, and longitudinals, with the view chiefly to effecting economy of weights. Under no circumstances was it considered safe to use steel for the outside plating of her Majesty's ships. The French Government were more enterprising in this particular, and in 1874 it was found that notwithstanding the treachery and imperfections of the steel supplied to their dockyards they were able, by carefully observing certain precautions, to work that material into their ships upon a larger scale than our own naval constructors felt justified in attempting. The keystone of the difficulty was to be found in this very question of care in manipulation. It was not doubted that the behaviour of the steel was governed by certain laws, and that a careful observance of those laws would be followed by success so far as the manipulation of the material was concerned. But, then, dockyard workmen are not skilled metallurgists, and to build ships with a material that required such careful handling was not only commercially impossible, but also impracticable, even at a Royal dockyard. Moreover, there was always the risk that by improper treatment the steel might be put into such a condition of initial strain by reason of changes in its molecular arrangement, as to cause a disaster to occur at sea to a vessel by a rupture occurring at a place where undue internal strain would be wholly unsuspected. For these reasons, then, our shipbuilders had no confidence in steel, although they had every desire to employ a more tenacious and ductile material than wrought iron if it could be produced at a moderate cost.

It was in 1875 that Sir N. Barnaby, then Director of Naval Construction at the Admiralty, uttered his famous challenge to the steel makers of Great Britain in the hall of the Society of Arts—at the annual session of the Institution of Naval Architects. That challenge was taken up at once, and in the following year Mr. James Riley, the manager of the Landore-Siemens Steel Works, appeared before the members of the same institution with a statement showing what had been done by the company he represented towards meeting the requirements indicated by Sir N. Barnaby. The Director of Naval Construction had said in the previous year—"The uncertainties and treacheries of Bessemer steel, in the form of ship and boiler plates, are such that it requires all the care which it has had bestowed upon it at L'Orient to avoid failure;" and had further declared that we wanted "a perfectly coherent and definitely carburised bloom, or ingot, of which the rolls have only to alter the form in order to make plates with qualities as regular and precise as those of copper and gun-metal, and we look to the manufacturers for it." Said he, "I am ready, for my part, to go further than the French architects have gone, and build the entire vessel, bottom plates and all, of steel; but I know that at present the undertaking will involve an immense amount of anxiety and care." By the spring of 1876 the Landore-Siemens Company had satisfied Mr. Barnaby and the Admiralty so far that they were then fulfilling a contract for the manufacture of steel for the entire hulls of the two armed despatch vessels Iris and Mercury, which were ordered to be built at Pembroke Dockyard. Lloyd's Register at once gave attention to the matter, caused a vast number of experimental tests to be made upon the new steel, and so satisfied were the committee with its behaviour that they proceeded without any delay to formulate rules for the construction of steel ships to be classed in their Register. The quality of steel described by Mr. Riley in 1876 is now being produced all over the country, and is known under the designation of "mild steel." Not only the Siemens-Martin, but also the Bessemer process is employed in its production; and attempts have been made to produce equally trustworthy steel by the comparatively new basic process, which, although not quite successful hitherto, will doubtless attain satisfactory results ere long. During ten years the cost of manufacture has been so reduced that the best shipbuilding steel can now be purchased at a lower price than was then paid for ordinary wrought iron. The employment of steel has correspondingly increased with the reduction in its cost, so that at present no less than 40 per cent. of the tonnage building in this country is constructed of a material which ten years ago had no commercial existence, and was, indeed, scarcely discovered.

The present seems, therefore, a fitting time to review the developments which have been made in steel shipbuilding, and to consider the experience which has been obtained with the use of steel in the shipyard, and with the behaviour of steel under the many tests to which they have been subjected. Hence it was not surprising to find three papers read upon the subject on the first day's meeting of the recent session of the Institution of Naval Architects, and a brief reference to these papers has already been made in the columns of this journal. It is to be regretted that so much of the subject-matter of two of the communications referred to related to a personal question with which the Institution had nothing to do. Some of the points brought under the attention of the members by Mr. Martell and Mr. Ward are, however, of the deepest importance to shipowners, shipbuilders, and underwriters. These relate to the old question alluded to by Sir N. Barnaby more than ten years ago, when he made his appeal to the steel manufacturers for a trustworthy material. Mr. Martell considers that it is still necessary to impose certain restrictions and regulations upon the use of steel such as he does not deem necessary in regard to wrought iron; and he produces excellent reasons for his opinions. Mr. Ward, on the contrary, has reached such familiarity in the use of steel that he has become contemptuous with regard to its alleged infirmities and peculiarities. He would, therefore, treat steel in the same way as iron, neither better nor worse—that is to say, he would permit the workmen to heat, hammer, and roll it to any extent they may please in fashioning it into shape, setting aside as bad only such pieces as fail under treatment. This is the invariable practice in shaping iron plates and bars, it being assumed that what is not cracked or broken is, therefore, sound, and fit to go into a ship.

Now this is admittedly a safe practice in dealing with iron, but it is not everybody who consider it prudent to handle steel in such a way. The instance cited by Mr. Martell of the fracture at sea of a ship's plates which had previously been exposed to undue heat through a fire near the loading berth of the vessel, shows that in one case at least, mild steel did not behave as ordinary wrought iron would under similar circumstances. On the other hand, as is well known to all familiar with the usual processes of a shipbuilding yard, it is a notorious fact that portions of a plate or bar are frequently heated and hammered without any injurious results following from that treatment. Indeed, if this could not be done, it would be unsafe to build steel ships without at least three times the amount of supervision which is now given to them by surveyors and inspectors. It is, in fact, doubtful whether any supervision at all would be effectual in preventing undue internal stresses from being set up in the molecular structure of the material of which a ship is built, if it cannot be safely handled by ordinary shipyard workmen. The importance of annealing thick butt straps in which the rivet holes are closely spaced, and of riming the punched rivet holes in thick plates of the bottom, may be admitted without at the same time accepting such limitations as would practically exclude steel from mercantile shipbuilding altogether. Generally speaking, whatever wrought iron is capable of with standing, can be much better withstood by mild steel, and this fact is made apparent by a comparison between the tests to which the two materials are subjected in order to determine their fitness for shipbuilding. The experience of ten years has shown that mild steel will usually endure very bad treatment without being seriously injured in regard to its ductility and tenacity. Instances are very rare in which the bottom plates of a steel ship have been penetrated by taking the ground, and it is not at all unusual for the bent plates to be taken off, rolled fair, and re-rivetted in place. Whether such treatment is judicious is quite another matter, and it is very doubtful whether a vessel repaired in such a way is in so good a condition as she was before she sustained the damage in question. From the point of view of a shipowner whose ship is insured, the mode of repairing her to which allusion has been made seems very objectionable; and, indeed, under any circumstances there cannot be that close agreement between the rivet-holes of adjacent plates which is essential to sound work when a stretched plate is rolled fair and replaced in that way. Consequently, while we may admit the possibility of replacing bent plates after being faired by rolling, the advisability of so doing will not be so readily conceded. It is, of course, very satisfactory to find that steel is capable of resisting blows which would penetrate iron, and that in itself should be a sufficient return for the slightly greater cost of the former material, without our wishing to use stretched and over-strained plates simply because they appear to be sound.

Something can therefore be said from both the points of view of the cautious user of steel and from that of the man who would treat steel and iron in the same way. The former must remember that it is the excellence of steel which has made it so popular and inspired shipbuilders with such confidence in its qualities that it is now commonly employed for the most considerably bent, twisted, and furnaced plates in an iron ship's bottom. The latter should bear in mind that the very excellence of the material may often cause defects in its structure to be hidden, which would be revealed by an inferior article; for it by no means follows because a steel plate or bar shows no signs of cracking that it is not overstrained, and therefore impaired in strength. Damage to iron is at once revealed by fracture, but damage to steel is often known only by a consideration of the treatment to which it has been subjected. While, therefore, steel is, in one sense, far superior to iron as a material for ships, it must yet be treated with more discrimination than iron, simply because it does not so readily disclose impaired conditions of ductility and tenacity. Nine hundred and ninety-nine out of a thousand of the operations in a shipyard are not calculated to do any violence to the structure of steel, if that of punching be omitted, but the thousandth establishes the necessity for taking care. The loss of strength resulting from punching is regularly restored by annealing or riming, and for the rest care must still be taken.

The corrosion difficulty has been overcome by carefully removing the mill scale previous to painting. As soon as this scale is got rid of, the risk of pitting and throwing off paint is at an end. Steel ships, which a few years ago were a source of much concern to their owners in consequence of rapid corrosion, are now no longer worse in that respect than their iron neighbours. Most shipowners take measures to free steel ships of the black oxide scale before they are launched, this being easily accomplished by the occasional application of diluted sal-ammoniac or hydrochloric acid.

The idea that steel ships will prove expensive to underwriters seems to be most fallacious. It is quite true that such vessels permanently alter their form when under stresses which would break an iron ship asunder. Several such cases have already occurred, and the impossibility of restoring those vessels to the same condition as they were in before being damaged, has made them constructive total losses. But then the underwriter has held the damaged ship as a set off to this claim of the shipowner for a new one; and although it has been impossible to make her perfectly fair and symmetrical, she has yet been repairable and made fit for service at a comparatively small cost. Both for the security of life and property a steel ship is to be preferred to an iron one, and for that reason the rapid increase in the proportion of steel ships built every year is to be welcomed. But to maintain the superiority of steel ships, it is essential that every care should still be taken in the manufacture and testing of steel, and that familiarity with the use of the material should not result in the neglect of those precautions which experience shows to be still necessary in its manipulation, and which are not necessary when we are dealing with iron.

THE DRAINAGE OF RICHMOND, SURREY.

In and around Richmond, Kew, Mortlake, and Petersham much interest is manifested throughout local engineering circles respecting the disposal of the sewage of the Richmond Union. A summary of the six separate schemes put forward by several engineers has already appeared in this journal. The one which gained the approval of the Urban Sanitary Authority of the Richmond Union should by this time, in the opinion of many, have been finally agreed upon by the Urban and Rural Sanitary Authorities of the Union alike. The want of progress in the matter is, however, only apparent. The Joint Sewerage Committee, comprising representatives from both authorities, have held several meetings and are still giving the matter their earnest attention. The Rural Sanitary Authority have availed themselves of the services of Mr. Baldwin Latham to secure an independent investigation of the proposed scheme. They desire to ascertain to what extent, if at all, their interests would be compromised by joining hands with the Urban Authority rather than dealing with a separate project for their own district. At the last meeting of the Joint Committee it transpired that the headings of Mr. Latham's report had been received, but that extended information was not yet available. Certain suggestions of the Rural Authority proposing modifications in the scheme as originally brought forward were considered, and the meeting then adjourned pending the reception of Mr. Latham's completed report. Further progress will, it is expected, be possible in about a week's time. The Joint Committee will then advance as rapidly as may be to the signing of the formal agreement under which both authorities combine to carry out the scheme. The next step will be an application for borrowing powers, to be followed by a Local Government Board inquiry—another of the series of similar inquiries extending over the several years during which this vexed question of the sewage has been arduously debated. Although a certain amount of opposition is inevitable at the inquiry, it is not anticipated that it will be formidable enough to interfere seriously with the application. On this point it is significant that at the recent rotation election of members for the Richmond vestry—to serve three years—three candidates, who were known to be adverse to the passing of the project in its present form, were defeated. The majority of ratepayers in the union are in favour of calling in the aid of the engineer as soon as possible to relieve them from a condition of things as dangerous to health as it is detrimental to property.

THE WITHAM NEW SEA CHANNNL.

The Witham New Sea Channel recently completed into the estuary of the Wash is one of the most important works in river engineering carried out in this country. The new channel is three miles long, and its sectional capacity is not only sufficient for the largest class of shipping, but in excess of that of the Suez Canal or the Amsterdam Ship Canal. Prior to the construction of the new channel thousands of acres of land in Lincolnshire, draining by the Witham outfall, were flooded during periods of heavy rainfall, and vessels of only 300 tons could reach the port of Boston. Now vessels of 2000 tons frequent the port, which bids fair to become one of the most important on the east coast, and the depression already acquired in the low-water level at Hobhole is 4ft., whilst the drainage sills of the grand sluice are dry at low water. This depression in the low-water level, so beneficial both to the drainage and navigation, is being gradually increased by the natural scour due to the new channel and the dredging of the hard and unyielding bars in the upper reach of the river. The new channel for about two-thirds of its length was excavated within the shelter of tidal embankments by aid of barrow and wagon roads and three powerful steam navvies advancing in *echélon* attended by eight locomotives, whilst the tidal or exposed section of the work was executed by training walls and dredging. The strata cut through consisted chiefly of silt, peat, and blue clay. The bottom or lower portion of the channel for the greater part of its length was formed in the boulder clay. The channel falls at the rate of 1ft. per mile seaward, with side slopes of 4½ and 4 to 1, and fascine work and cliff stone have been used for the protection of the faces. The old circuitous channel was untrained and broken through a mass of shifting sands, and its permanent closing formed a most difficult element in the scheme, but was successfully accomplished in August, 1884. Since then the new sea channel has been largely used, to the great advantage of the drainage and navigation. The works were designed and carried out for the Witham Outfall Board by Mr. J. Evelyn Williams, M.I.C.E., and the contractor was Mr. Thomas Monk, of Liverpool. In continuation inland of the improvement of the outfall, the grand sluice has been enlarged, and the Witham improved for a reach of twelve miles above the sluice, the aggregate cost of the works being about £200,000.

FOREIGN VESSELS IN THE COAL TRADE.

Some time ago we referred to the comparatively large number of vessels engaged in the foreign coal trade which were foreign owned. It may be of interest now to give the details for a recent month. In April there were about 390 vessels leaving the Tyne coal laden, and out of these there were 255 British and 135 foreign. From North Shields the numbers were 15 all British, and from South Shields 31 British, 9 foreign, so that from the Tyne ports there were 301 British ships and 144 foreign. From the Wear in the same month the vessels were 69 British and 54 foreign; and from Seaham, 9 British. At Blyth there were 21 British and 35 foreign; and at Amble, 14 British and 15 foreign. At West Hartlepool the numbers were 26 British and 28 foreign; at Middlesbrough, 8 British and 10 foreign. At Hull, 79 British and 18 foreign; and at Grimsby 27 British and 24 foreign. At Liverpool the numbers were 52 British and 18 foreign for the month; at Cardiff, 280 British and 79 foreign; at Newport, 95 British and 36 foreign; and at Grangemouth, 29 British and 42 foreign. It is needless to give more examples, for these illustrate the variations in the proportions of the nationalities of the coal carrying vessels. But it is at least certain that there is a considerable proportion of the coal sent away from this country which is so exported in foreign vessels steam and sailing. It would be satisfactory if we had fuller details of the countries to which the coal is so carried, and if we could learn whether it is carried in the vessels of those countries; but on those points the official return from which we quote our figures is silent. It would be an interesting topic to inquire into; to ascertain whether there is any portion of that trade due to the fact that we are losing our small sailing vessels, and that other nations are doing the trade which was done by them, and which our large steamships are unable to perform as well, and it would seem as if there were a need for the construction of small and cheaply-worked steam vessels, capable of doing the work which was done by the sailing craft we once had, and have lost, and have not replaced. It is in some such way as this, it is probable, that we could regain a larger share of that part of the coal trade we seem to have lost—the carriage of coal to foreign countries in what seem to be, on the average, comparatively small cargoes to one place at one time.

TRIAL OF GRUSON'S ARMOUR AT SPEZIA.

No. III.

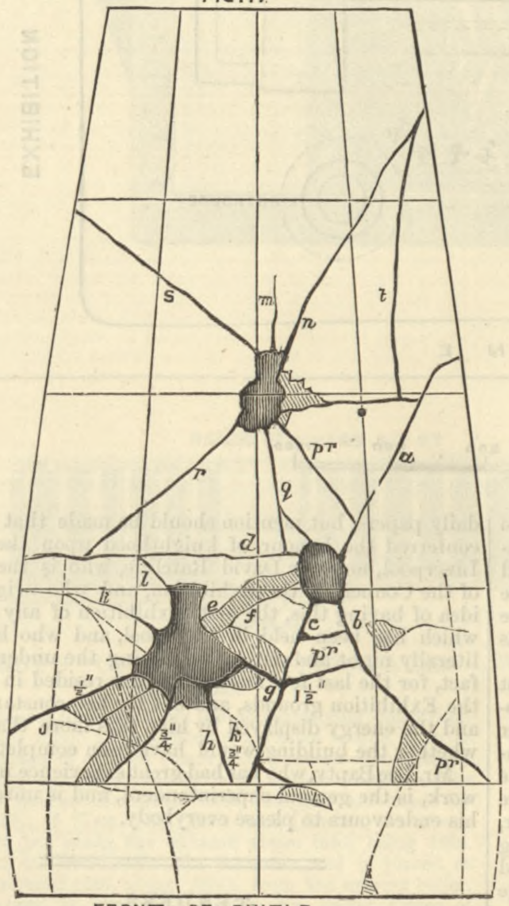
A THIRD round was fired at the Grüson shield on Thursday, April 29th, from the Elswick 100-ton breech-loading gun, the firing conditions being as nearly as possible the same as in the two previous rounds. The third Krupp forged steel projectile was employed, its weight being made up to 1000 kg., or 2204·6 lb.—nearly a ton. The charge was again 375 kg.—826·7 lb.—of Cologne prismatic powder. The striking velocity was 536·1 metres or 1758·9ft. per second; the striking energy being therefore 14,651 metre tons, or 47,306 foot-tons. Pressures in the bore were registered as 2010, 1973, 1985, and 2025 atmospheres, the mean being 1998 atmospheres, or 13·11 tons per square inch. The charge in each round was made up in four cartridges ribbed longitudinally with serge rolls so as to make the charge lie in the bore with a space round it. The crusher gauges, tubes, and obturator, were, of course, as employed at Elswick. It may be noticed, by the way, that the de Bange asbestos ring, which answers remarkably well with small guns, has given considerable trouble by setting up in guns of larger bores. The following table gives the details as to velocity and energy of each round more exactly and fully than we have hitherto stated them :—

Ballistic Power of 100-*ton Breech-loading Armstrong Gun Fired at Spezia on April* 20*th*, 24*th*, *and* 29*th*, 1886.

Number of round.	First.	Second.	Third.
Velocity at muzzle in metres	541·2	541·9	540·1
,, ,, in feet	1775·6	1777·9	1772·0
,, at 85 metres in metres... ...	538·6	539·3	537·5
,, at 278·9 in feet	1767·1	1769·4	1763·5
,, at point of impact in metres	537·2	537·9	536·1
,, ,, in feet ...	1762·5	1764·8	1758·9
Energy at muzzle metre-tons	14,929	14,966	14,871
,, ,, foot-tons	48,207	48,326	48,019
,, at point of impact metre-tons...	14,709	14,747	14,651
,, ,, foot-tons ...	47,499	47,629	47,306
,, ,, per in cir. foot-tons	892·8	896·9	888·6
Perforation in wrought iron at striking, inches	31·2	31·2	31·1
Angle of incidence of projectile with tangent to shield	40 deg.	44 deg.	34½ deg.
Energy in foot-tons at impact per ton of shield	548·9	550·1	546·4

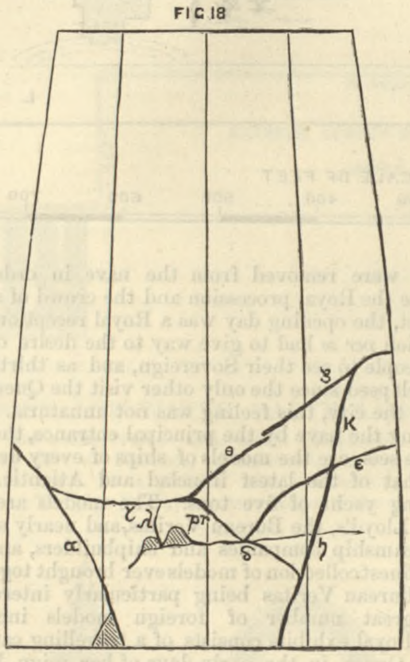
After the second round, owing it is said to the impossibility of masonry and cement supporting the iron shield as well as the contiguous iron plates of a cupola or iron fort, a slight space had opened behind the edge of the plate on either side. In fact there had been sufficient yielding to cause a little anxiety as to the conditions under which the shield would receive the third shot.

FIG. 17



FRONT OF SHIELD DEVELOPED

FIG 18



This was delivered on a spot close to the centre line running down the shield and about a metre from Round 1—see Fig. 17, on which the cracks are shown in the front of the shield by continuous lines, and on the back in dotted lines seen through as if the shield were transparent. The angle of incidence being more oblique than before, the indent of the projectile was less, being about 1½in. The projectile flew into smaller pieces than before apparently, but the blow was sufficient to crack the shield, which is much thinner here, in lines shown in Fig. 17 as *m*, *n*, *o*, *p*, *q*, *r*, *s*, and *t*, as well as a small crack connecting *q* with point of impact 1. The portion of plate between *t* and the edge was entirely separated from the rest of the shield, so that it could be removed. It extended to the depth of about a foot at the plate edge, but rapidly curved up to the surface at *t*. In spite of this cracking and splitting, however, the shield appeared not only to be in condition to receive another blow, but Herr Grüson thought its position improved, inasmuch as it had so sprung as to close the opening visible at the last round, and was therefore now better supported. In the inside, cracks η, κ, ζ, θ, and λ (see Fig. 18) were formed and two very small pieces were detached near λ (*vide* Fig. 18), where the plate had obviously felt the blow severely, the fragment in the centre marked *p r* projecting slightly and the cracks there being deep and opened.

On the whole the shield had acquitted itself admirably, for it had borne the three blows without any piece of any importance being dislodged in the inside. The small pieces from parts shown shaded which came off appear to have been shaken and dropped down rather than flown out, and a detachment of men behind this shield would have remained uninjured. Bolt heads generally fly with violence because their fracture is due to a strain on the bolt, which causes them to spring into the interior. This does not seem to be the case with pieces that may be dislodged by cracking. At all events it must be admitted that the defensive power of a shield which resists three blows of the projectile of the most powerful gun in existence is remarkable.

We may add that such a judgment was expressed by the Commission that Herr Grüson was able to telegraph in the afternoon to push forward the manufacture of the plates required for the two cupolas.

The question was raised, as it was inevitable should be the case, as to the excellence of the Krupp projectiles which had thus broken on the shield. One or two queer looking bits were found, and persons stated that they found pieces that proved rather soft under the file. We do not, however, feel that there was anything to shake our belief in the projectiles being excellent. At all events nothing could be a fairer proposal than that which was made by Krupp's agent, M. Otto Budde. It appears that a competitive trial of steel 15 c.m. projectiles has been carried on at Muggiano, Spezia. In this Krupp's have proved themselves the best. Shells of 15 cm. have been fired point blank at very thick steel plates—about 18in. thick, we think. These entered to a depth of about 1½ calibres, and rebounded without alteration of form, so that they can be again fired. M. Budde suggests that these projectiles, whose quality has been thus proved to be extraordinary, should be fired at the Grüson shield, against which, striking obliquely as they must do, they will break up exactly in the same way as the large projectiles, so he states.

There was a wish expressed to see a French St. Chamond steel projectile fired against the shield. These are excellent, but they are said to be softer than Krupp's, and the question arises as to what are the qualities that are most needed in shot to enable them to act well against chilled iron armour. On this matter we have literally no experience in England. Krupp's belief appears to be that the blow delivered by the shot depends on its limit of elasticity. Not that the projectile has the opportunity of recovering its form when the strain falls within this limit, but rather probably because no sensible change of form really takes place within it, and because directly deformation commences the resistance of the shot decreases so rapidly that little more work can be got out of it. We should, however, have thought that the ultimate tenacity as well as the limit of elasticity would be the measure of the shot's power in this case of oblique impact. In direct impact undoubtedly, on deformation commencing, all penetration comes quickly to an end, but where no penetration in the ordinary sense can be effected, surely as long as the projectile holds together, so long it impresses its energy on the shield at the point of impact. As deformation commences its power rapidly declines, but still after commencing an injury, any following up of the blow at the exact spot acts in so telling a way that we should have supposed that between the limit of elasticity and that of ultimate tenacity a sensible amount of work existed, and that the latter limit as well as the former should be considered. Indeed, slight deformation may exist without destroying even the power to perforate. Whitworth's steel projectiles in the competitive trials in England set up slightly, and yet were able to perforate plates that proved too much for most projectiles again and again.

With regard to St. Chamond and other French steel projectiles, little is known out of France, but we hear that at Gâvre great results have been obtained. It is expected that steel projectiles should perforate steel plates about a calibre and a quarter thick without deformation. In this country it is commonly stated that French steel plates are being made soft. This appears to be true in a measure; nevertheless, the French compound plates, whose powers we know are not very different from our own made on the same patent, are perforated more easily than the French steel plates. We have seen so much of the excellence of Krupp's steel projectiles, that we should need a good deal of evidence to make us accept the statement that the French were as good, or better; but it may be so. One thing is, unfortunately, quite clear, namely, that England has dropped far behind in the matter of steel projectiles, and we fear that until we try really hard armour in this country we may continue to place too much confidence in our chilled iron shells. We believe that these are, of their sort, excellent, possibly the best in the world; but in France, Germany, and Italy, it has been found absolutely useless to fire any chilled projectiles at really hard armour. Surely it would be mad to expect that our chilled shot would be of much use against a Grüson shield unless we prove this to be the case by actual trial. A Grüson shield erected at Shoeburyness would teach us so much as to our neighbours' armour and as to our projectiles, that we greatly wish to see such a shield tested. A shield is surely worth trying for its own sake, which, so long as it holds together, offers complete security to the battery behind it, and which can be made to keep out three projectiles, any one of which would have gone clean through almost any armour we possess either on ships or forts. It is still more important to try it for the sake of the knowledge it affords us of the power of our own projectiles against foreign armour. It can hardly be doubted by any one that we are far behind in the matter of projectiles. French steel shot go through at least a calibre and a-quarter thickness of steel without deformation, and Krupp projectiles enter a calibre and a-half into steel armour of thickness totally disproportionate to the shot, and bound back apparently undeformed and uninjured. We cannot afford to leave the matter in this state. Happily the 100-ton breech-loading gun that formed the central figure in the Spezia trial keeps up the credit of English artillery material. English hydraulic machinery also from Elswick will, as before said, be employed to work the turrets.

ROSARIO WATERWORKS.

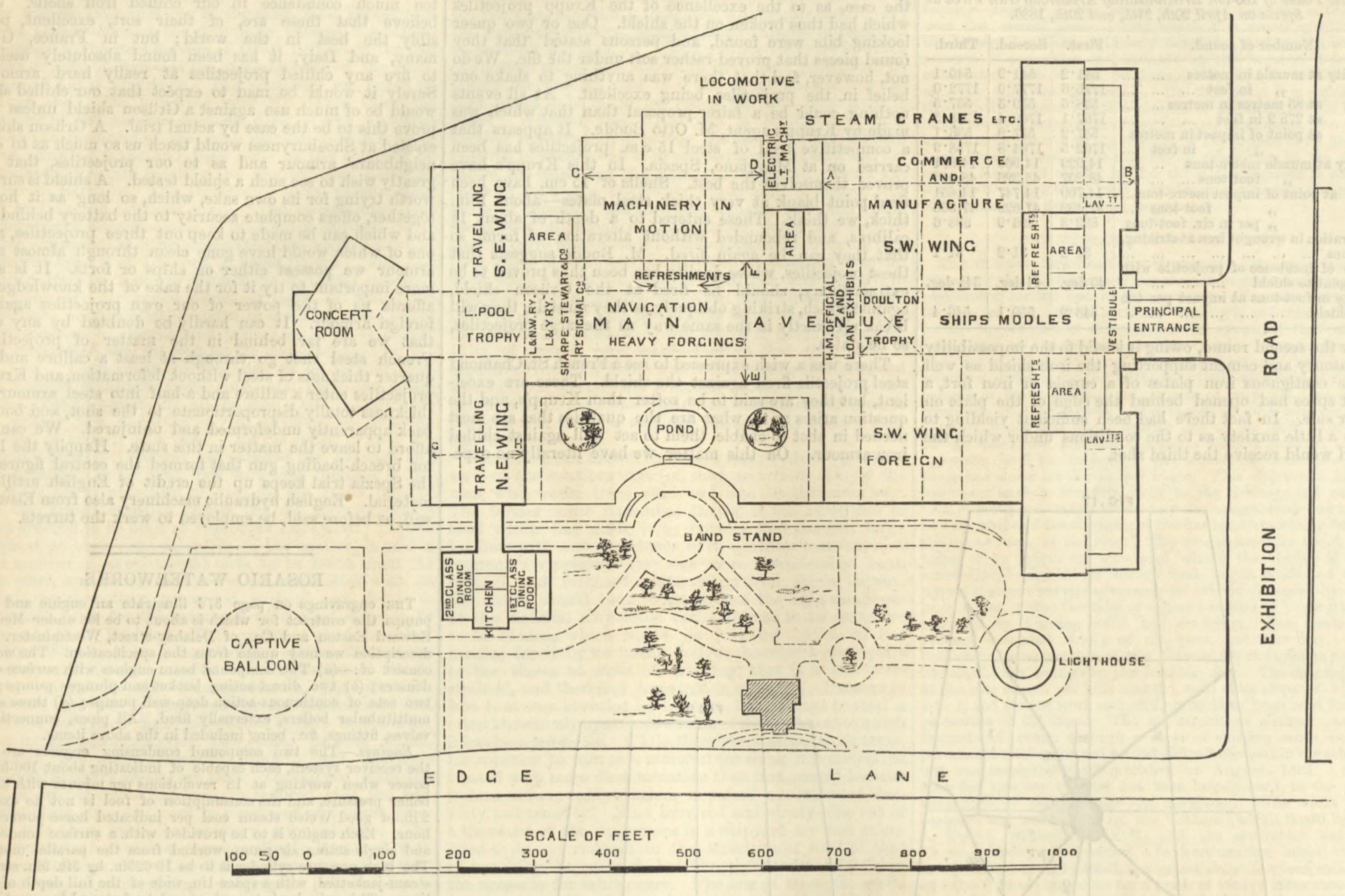
THE engravings on page 376 illustrate an engine and the pumps the contract for which is about to be let under Messrs. Edward Easton and Co., of Delahay-street, Westminster. In description we may quote from the specification. The works consist of:—(*a*) Two compound beam engines with surface condensers; (*b*) two direct-acting bucket and plunger pumps; (*c*) two sets of continuous-action deep-well pumps; (*d*) three steel multitubular boilers, externally fired. All pipes, connections, valves, fittings, &c., being included in the above items.

Engines.—The two compound condensing engines are on the receiver system, each capable of indicating about 100-horse power when working at 18 revolutions per minute with 85 lb. boiler pressure, and the consumption of fuel is not to exceed 2 lb. of good Welsh steam coal per indicated horse-power per hour. Each engine is to be provided with a surface condenser and single-acting air pump worked from the parallel motion. The high-pressure cylinder is to be 19·625in. by 3ft. 9in. stroke, steam-jacketted, with a space 1in. wide of the full depth of the liner. This cylinder is to rest on and be fastened to a cast iron foot bolted to the cylinder bed-plate. The low-pressure cylinder is to be 30in. diameter by 5ft. 6in. stroke, with a steam jacket 5in. wide, the whole depth of the liner forming a receiver. The specification stipulates that the liners of both cylinders are to be fitted to the jackets in such a manner as to allow of expansion and contraction, and both the cylinders are to be fastened to each other by brackets cast on the sides and to the cylinder base plate at the bottom. The steam ports are to be as short and direct as possible, of suitable area, but not too large. Both cylinders are to have variable expansion valves capable of adjustment by hand while the engine is running. The cut-off slides and gearing are to give a sharp cut-off from one-sixth to one-half stroke in each cylinder. The slide valves are to be double, of the short D type, made of cast iron, with cut-off slides on their backs, working in long steam chests. The steam chests are to drain into the jackets by means of holes drilled through. Instead of slide valves, as above described, a good and efficient arrangement of piston valves can be submitted for the approval of the engineer. The valves are to be worked by means of excentric rods and levers connected to the lay shafts actuating the vertical spindles of the valves; but this arrangement may be altered to suit the hand gearing finally determined upon. The excentrics are to be of cast iron, fitted with wrought iron straps lined with gun-metal. The exhaust steam from the high-pressure cylinder is to discharge into the receiver jacket round the low-pressure cylinder. The pipes are to be of copper and the cocks of gun-metal, the connections are all to be of brass, and all bends where possible are to be of the same metal, so as to avoid bending the tubes. Gauges are to be fixed at the back of the low-pressure cylinder, connected by means of bent copper pipes to the steam supply pipe, receiver, and condenser. Pistons are to be of cast iron, with hollow spaces filled with non-conducting material, and to have adjustable packing rings. The connecting-rod is to be of wrought iron, swelled in the middle to 7in. diameter, and fitted with wrought iron strap, steel gib and cotter, split brasses, and lubricator at each end. The crank and fly-wheel shaft to be of wrought iron, with all necks and collars forged on except the crank pin, which is to be of steel, fitted and keyed into the eye of the crank. There is to be a heavy fly-wheel, 18ft. diameter, in four pieces, with ratchet teeth cast round the centre of the face; fly-wheel not to weigh less than 15 tons. The feed pump is to be of the single-acting plunger type, fitted with air vessel and self-acting bye pass and cock, the valves, plunger, and gland being of gun-metal. The condensing surface of the tubes not to be less than 250 square feet. The body of condensers to be cast iron, tubes and tube plates to be of Muntz metal. The water—1200 gallons per minute—from each of the deep-well pumps will pass through each condenser. The air pumps are to be single-acting, to be of ample capacity to maintain a good steady vacuum equal to 27in. of mercury.

Pumps.—The bucket and plunger pump to each engine will be worked from the beam; it is to be 2ft. 4in. diameter by 2ft. 9in. stroke, and deliver 1200 gallons per minute against a head of about 120ft. above the pump barrel, including friction in pipes. The barrel of cast iron, lined with gun-metal ½in. thick. The suction is to be 20in. diameter. Suction tank to be of cast iron, 4ft. 6in. diameter, 12ft. 6in. deep, with loose cover on top, the delivery to be 16in. diameter. There is to be a 16in. sluice cock on the vertical part of the delivery under the air vessel. A small Westinghouse air pump to be provided for filling the air vessels. There is to be a continuous action pump to each engine, 24in. diameter by 1ft. 9in. stroke, delivering 1200 gallons per minute against a head of about 100ft., including suction and friction in pipes. The pump consists of two working barrels connected together, and two buckets worked from the beam direct.

Boilers.—There are to be three boilers of the multitubular

GROUND PLAN OF THE LIVERPOOL EXHIBITION.



type, each 14ft. by 7ft. diameter, with 112 3¾in. steel tubes inside; the shell and plates and steam drum are all to be of mild steel, and the stays, rivets, caulking rings, &c., being of similar material. Each boiler is to be adapted to a maximum working pressure of 85 lb. on the square inch, with a factor of safety of 6, to be tested to 150 lb. in the contractor's workshop, and again when in position. Front and back plates to be each in one piece. There are to be six longitudinal stays, rivets of mild steel, two safety-valves per boiler, one a lock-up spring valve, the other of Cowburn's dead-weight type.

THE LIVERPOOL INTERNATIONAL EXHIBITION.

No. I.

THIS Exhibition, perhaps the most ambitious undertaking of its sort that has ever been undertaken in this country out of London, was opened on Tuesday last by her Majesty the Queen, with great ceremony, and in the presence of an enormous concourse of spectators.

The erection of the building has been attended with great difficulties from its commencement, and at one time it seemed hopeless to expect that it would be completed by the time originally contemplated, viz., May 1st.

The Corporation of Liverpool, who are the proprietors of the site, which will hereafter be utilised as a public park, undertook to level the ground; but considerable misunderstanding arose as to the amount of work to be performed, as the site was exceedingly irregular and full of old excavations for brick clay, &c.

The Exhibition authorities required an absolutely *level* site for their building, whereas the Corporation only contemplated filling up the excavations and removing irregularities. Eventually this work was accomplished, but at a much greater outlay than was originally contemplated. Owing to the irregularity of the site, a large portion of the floor of the building stands a good deal above the original level of the ground. This involved the construction of brick foundation walls of considerable height, and the continued frost of the early part of this year interfered materially with the execution of this work. Shortly after the erection of the ironwork was commenced, a very serious accident occurred, and a considerable portion of the building collapsed. A steamer conveying the ironwork from Antwerp to Liverpool was sunk by collision at the mouth of the Mersey, and later on a heavy gale brought down another portion of the building. Under these adverse circumstances great credit is due to the Exhibition authorities and the contractors for having completed the building in the time; and if the exhibits and courts were not in that finished condition at the opening which one would have desired to see them, the Liverpool Exhibition is not at all singular in that respect, and the general appearance of the nave during the ceremony left little to be desired, although some portion of the building through which her Majesty was conducted, especially the Foreign Courts, were practically empty of exhibits. Still the crowd of spectators served to conceal the true state of affairs.

The plan of the building we give above, which will supply an idea of the magnitude of the Exhibition and of the character of the exhibits; but it is impossible, in the present state of affairs, to attempt any detailed description. Many important articles which were delivered, and some actually in position, were removed from the nave in order to accommodate the Royal procession and the crowd of sightseers; in fact, the opening day was a Royal reception, and the Exhibition *per se* had to give way to the desire of the Liverpool people to see their Sovereign, and as thirty-five years have elapsed since the only other visit the Queen has ever paid to the city, this feeling was not unnatural.

On entering the nave by the principal entrance, the first objects to be seen are the models of ships of every description, from that of the latest ironclad and Atlantic liner to the racing yacht of five tons. The models are contributed by Lloyd's, the Bureau Veritas, and nearly all the principal steamship companies and shipbuilders, and are perhaps the finest collection of models ever brought together, that of the Bureau Veritas being particularly interesting from the great number of foreign models included in it. The Royal exhibits consists of a travelling carriage used by the Queen in the early days of her reign, before railways extended to all parts of the country, and some handsome Russian sledges.

The Doulton trophy under the dome is the most conspicuous object in the nave, and is a beautiful work of art, one window being painted to represent the Royal William steamer starting on her first voyage across the Atlantic, and the other showing the Umbria, and thus affording a striking contrast between the first Atlantic steamer and those of the present day. The Royal throne was placed at the east end of the Doulton trophy. The Liverpool trophy consists of an elaborate case, containing samples of the principal articles imported into Liverpool. The most imposing engineering exhibits in the nave are the Webb compound locomotive, "City of Liverpool," sent by the London and North-Western Railway; the tank engine made by Messrs. Sharp, Stewart, and Co. for the Lancashire and Yorkshire Railway, which will be illustrated in these columns; the composite carriage for the same railway; and the old engine "Locomotion," constructed, in 1825, by George Stephenson. This engine was originally employed on the Stockton and Darlington Railway in drawing coal trains, and is antecedent to the more celebrated Rocket. The Locomotion has stood for many years on a pedestal at Darlington station, and has been lent to the Liverpool Exhibition by the North-Eastern Railway Company.

The Railway Signal Company, of Fazakerley, near Liverpool, make a good display of their level crossing gates and signals, which will be fully described in a future number.

Messrs. Jessop and Sons show double-throw cranks of cast steel, ship stern frames and rudders.

Messrs. John Brown and Co. have on view an armour plate 22in. thick and other specialities.

The Mersey Forge have a fine collection of shafts, including a crank shaft weighing 33 tons; Messrs. Cammell and Co. a built crank shaft, and Mr. John Dickenson, of Sheffield, a 45-ton crank shaft.

Messrs. Fox make an effective display of their corrugated boiler flues, but all detailed description of the engineering articles must be reserved until matters are in a more settled condition; and in fact the real installation of the principal exhibits did not commence until after the opening ceremony.

The inaugural ceremony has been fully described in the daily papers, but mention should be made that the Queen conferred the honour of knighthood upon the Mayor of Liverpool, now Sir David Ratcliffe, who is the chairman of the Council of the Exhibition, and who originated the idea of having this, the first, Exhibition of any magnitude which has been held in Liverpool, and who has worked literally night and day in promoting the undertaking; in fact, for the last few months he has resided in a house in the Exhibition grounds, and but for his constant presence and the energy displayed by him, it is more than doubtful whether the building would have been completed in time.

Mr. Lee Bapty, who has had great experience in exhibition work, is the general superintendent, and is unremitting in his endeavours to please everybody.

TENDERS.

TOXTETH PARK.

TENDERS received for the completion of Moss-grove for the Toxteth Park Local Board. Quantities supplied by the engineer, Mr. John Price, Assoc. M. Inst. C.E.

	£	s.	d.
Sayce and Randle, Widnes	506	3	8
Ireland and Hurley, Brae-street, Liverpool	364	1	0
W. F. Inglis, Castle-street, Liverpool	319	0	10
C. Burt, Wellington-road, Liverpool	310	0	0
L. Marr, Aspen-grove, Liverpool	300	2	3
J. Nuttall, Moss-lane, Manchester	294	3	9
R. Lomax, Alma-street, Eccles	288	5	3
W. F. Chadwick, Howard-street, Liverpool	284	2	7
Anwell and Co., Park-road, Liverpool	272	2	2
Walkden and Co., Brasenose-road, Bootle—accepted	245	19	0
S. McCullah, Lucerne-street, Toxteth Park	231	16	3
Engineer's estimate	260	0	0

Tenders received for the completion of Sefton-grove for the Toxteth Park Local Board. Quantities by the engineer, Mr. John Price, Assoc. M. Inst. C.E.

	£	s.	d.
Sayce and Randle, Widnes	273	8	1
J. White, Aigbarth Vale, Liverpool	211	2	11
C. Burt, Wellington-road, Liverpool	210	0	0
Ireland and Hurley, Brae-street, Liverpool	209	17	9
R. Lomax, Alma-street, Eccles	207	13	0
W. F. Inglis, Castle-street, Liverpool	206	18	0
J. Nuttall, Moss-lane, Manchester	203	8	9
McCabe and Co., Lambeth-road, Liverpool	198	11	3
Anwell and Co., Park-road, Liverpool	182	7	3
L. Marr, Aspen-grove, Liverpool	181	8	4
W. F. Chadwick, Howard-street, Liverpool	177	18	4
Walkden and Co., Brasenose-road, Bootle—accepted	161	15	0
Engineer's estimate	165	0	0

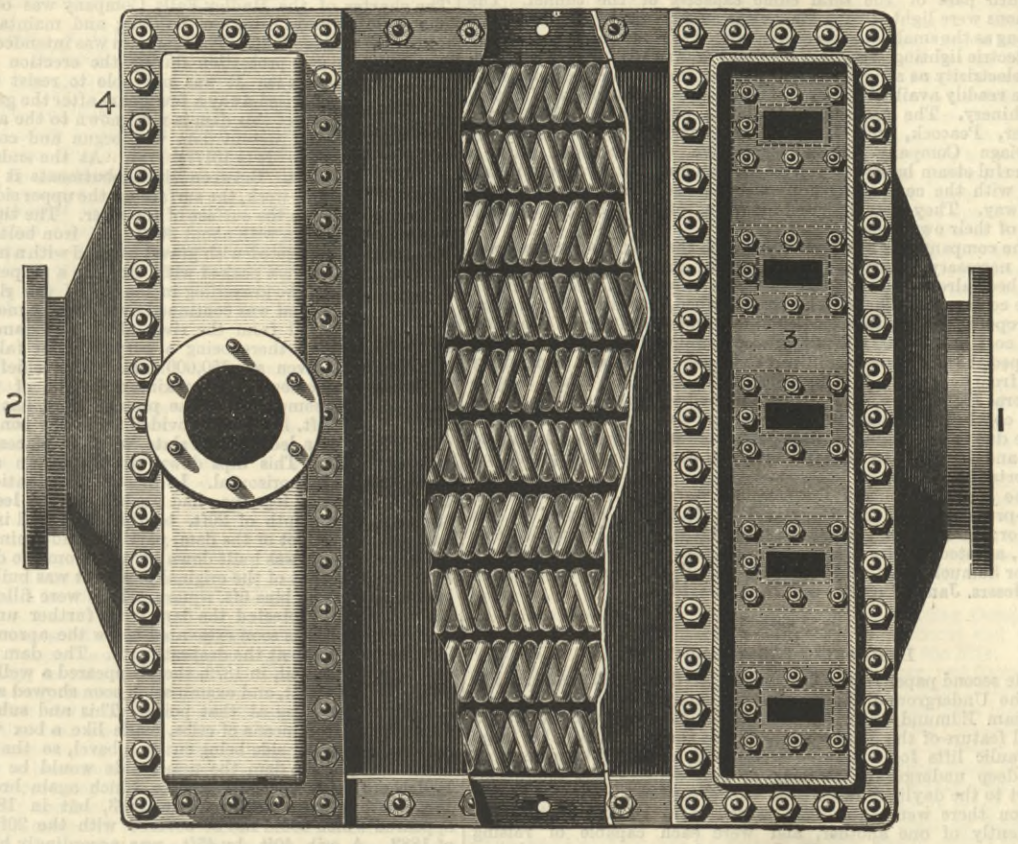
Tenders received for the completion of Maple-grove for the Toxteth Park Local Board. Quantities by the engineer, Mr. John Price, Assoc. M. Inst. C.E.

	£	s.	d.
Sayce and Randle, Widnes	342	13	3
W. F. Inglis, Castle-street, Liverpool	238	17	6
Ireland and Hurley, Brae-street, Liverpool	222	19	3
C. Burt, Wellington-road, Liverpool	220	0	0
J. Nuttall, Moss-lane, Manchester	206	7	6
R Lomax, Alma-street, Eccles	202	16	0
L. Marr, Aspen-grove, Liverpool	198	19	4
McCabe and Co., Lambeth-road, Liverpool	194	6	3
Anwell and Co., Park-road, Liverpool	189	1	9
W. F. Chadwick, Howard-street, Liverpool	186	10	1
Walkden and Co., Brasenose-road, Bootle—accepted	167	0	0
Engineer's estimate	185	0	0

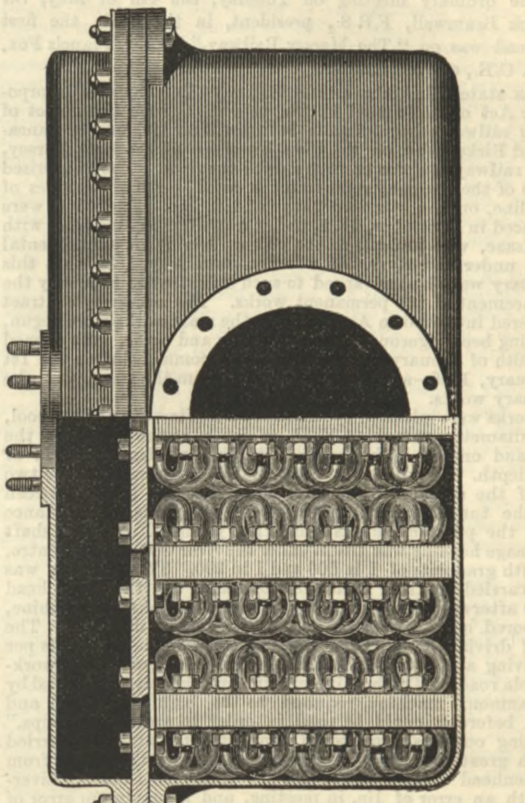
NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—William Walker, engineer, to the Hercules; William H. Pippett, assistant engineer, to the Surprise.

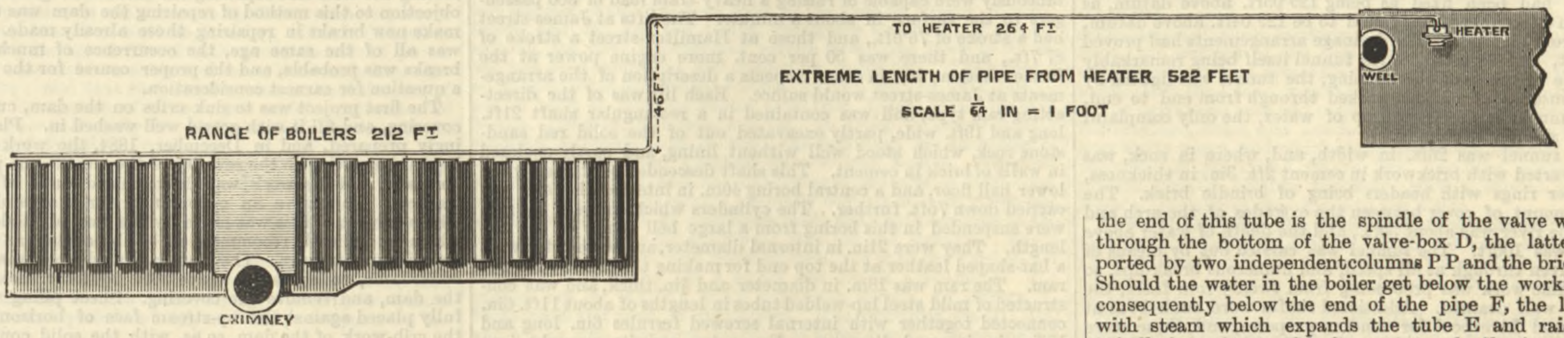
"COMPACTUM" FEED-WATER HEATERS.

MR. J. KIRKALDY, WEST INDIA DOCK-ROAD, ENGINEER.



SCALE 1" = 1 FOOT





KIRKALDY'S "COMPACTUM" FEED-WATER HEATERS.

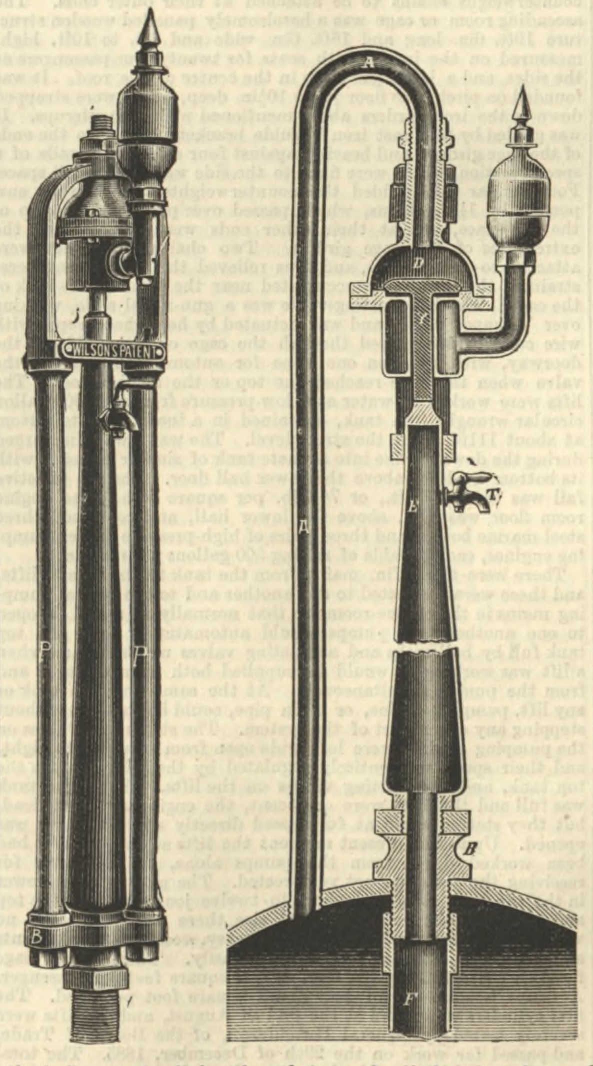
THE feed heater illustrated by the accompanying engravings is one of a type which has produced remarkable results, both as a heater by means of exhaust steam and by means of live steam. The engravings show an especially large heater erected in the works of the Barrow Hematite Steel Company, and made by Mr. J. Kirkaldy, of West India Dock-road, London. It is one of the largest yet made, the exhaust steam inlet being 16in. diameter, and the feed-water 6in. diameter, and is placed, as seen in the annexed plan, about 308ft. from the nearest boiler. After it had been at work four months, Mr. David Evans, of the Barrow Steel Works, found that its working fully satisfied him, and writing in March last, said—"The feed-water for sixteen double flued Lancashire boilers is passed through the heater, and as it is drawn through the town mains it is cold. The average temperature after leaving the heater is 170 deg. With from ten to twelve boilers at work the temperature of the feed varies from 195 deg. to 200 deg. The boilers supply steam to four sets of engines. The saving of fuel is from 10 to 11 per cent., and the internal plates of the boilers are clean."

The boilers referred to are 32ft. in length by about 8ft. in diameter, and it will be easily seen that a saving of 10 per cent. of the fuel burned by this powerful battery of boilers would probably represent at least two railway truck-loads of coal per week.

The construction of the heater is such that by taking out the flange bolts the whole of the tubes are removable on one tube plate. Fixed to either end of the tube plate, as shown in the section and at 3, are five main or trunk tubes. To either side of these are connected by screw joints the coiled corrugated tubes running from top to bottom. Through these tubes the water passes. The construction and the high efficiency of these corrugated coils we have before described. It is found that the slight opening and closing of the coils under change of temperature keeps them free from deposit. One of the heaters heated by live steam and supplying feed-water to three boilers in a cement works, where it was expected that the water would rapidly make it necessary to remove incrustation, it was found after two months that the heater tubes were clean, and from whatever cause the gain may arise, improved working conditions, circulation or what, the owners of these boilers acknowledge a saving by the use of this live steam heater of 13 per cent. No one can explain where a gain by using live steam to heat feed-water can come from, but the experience of many is the same. The Duke of Sutherland's yacht is fitted with one, and last year a distinct saving was ascertained soon after its use, but many doubts having been expressed, a careful trial on an extended run has recently been made, and a report made by Mr. Wright, the Duke's secretary. On the 26th and 27th February last, tests were made extending over twenty-four hours. The engine was running at 80 revolutions per minute and the heater not in use. The coal measured as used was found to be 6 tons. In the following twenty-four hours, the engines running at the same speed, and the heater being in use, it was found that the coal consumed weighed 5 tons 2 cwt. These, with other facts which have been vouched for by those who have made the trials, seem to be quite sufficient for the steam user. Something is, however, wanted to satisfy theory. The efficiency of these heaters, as feed heaters, whatever the source of the steam used, is, however, remarkably high, as we have previously shown.

WILSON'S LOW-WATER VALVE AND ALARM.

THE low-water valve and alarm illustrated herewith is made by Mr. J. Fletcher, of Ashton-under-Lyne. Its construction may be explained with its action, which is as follows:—The pipe F, which is screwed on to the casting B inside

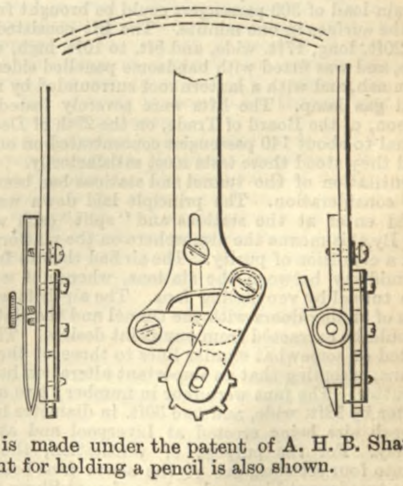


the boiler, is of sufficient length to reach a little below the usual working level of water in the boiler, so that when the water is at its normal height, the expansion tube E, which is outside the boiler and exposed to the air, is full of water, the air having previously been let out through the test-cock; in contact with the end of this tube is the spindle of the valve which projects through the bottom of the valve-box D, the latter being supported by two independentcolumns P P and the bridge casting C. Should the water in the boiler get below the working level, and consequently below the end of the pipe F, the latter is filled with steam which expands the tube E and raises the valve spindle in contact with its upper end, allowing steam to pass the valve and blow the whistle. The advantages of this apparatus are simplicity of construction, absence of springs, floats, stuffing-boxes, levers, fusible alloys, &c. The small test tap T, near the top of expansion tube E, is placed for the purpose of the inspector or any person in charge, at any time to test the efficiency of the instrument. The tap T, when opened, simply allows the cool water to escape, and is replaced with water at the temperature of the steam—or nearly—the action being exactly the same as the above description.

It will be seen that it cannot very well get out of order, as it has no stuffing-boxes, springs, floats, levers, or fusible alloys. It is free to expand without any friction, and therefore is not liable to stick; it cannot be tampered with when the boiler is either at work or at rest, and will give unmistakeable warning that danger is approaching to all within the sound of the whistle when the water falls below the fixed level. It is claimed that this alarm is specially suitable for furnace boilers heated by the waste heat of puddling and blast furnaces, and where fusible plugs are useless; also for all boilers limited in internal space. The whistle is designed to sound at varying pressures, from 3 lb. to 100 lb. per square inch, which is not the case with ordinary whistles.

SHARPE'S DOTTING PEN.

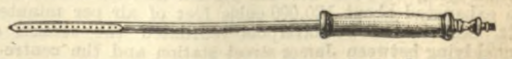
THE dotting pen illustrated and explained by the annexed



engraving is made under the patent of A. H. B. Sharpe. An arrangement for holding a pencil is also shown.

HILL'S GAS POKER.

THE gas poker, illustrated by the accompanying engraving, is made, with certain improvements of Mr. Hill's invention, by Messrs. E. Page and Co., Bedford. It will give sufficient flame



to light an ordinary coal fire instantly, or boil a kettle of water without other fuel, in the customary grate, when attached to a gas burner in the usual way by india-rubber gas pipe. It is very simple, efficient, useful, and saves much time and trouble

THE INSTITUTION OF CIVIL ENGINEERS.

THE MERSEY RAILWAY.

At the ordinary meeting on Tuesday, the 4th of May, Sir Frederick Bramwell, F.R.S., president, in the chair, the first paper read was on "The Mersey Railway," by Mr. Francis Fox, M. Inst. C.E., of Westminster.

It was stated that the Mersey Railway Company was incorporated by Act of Parliament in the year 1866, with the object of effecting railway communication between Liverpool on the Lancashire and Birkenhead on the Cheshire shore of the river Mersey, and the railway systems on each side of the river. The authorised railways of the company represented a total length of 5¼ miles of double line, on the standard gauge of 4ft. 8½in. The works were commenced in December, 1879, under a preliminary contract with Major Isaac, who undertook the risk of driving an experimental heading under the river. It was not until May, 1881, that this preliminary work had advanced to such an extent as to justify the commencement of the permanent works. The necessary contract was entered into, and in August, 1881, the main works were begun, and having been vigorously prosecuted day and night, were opened on the 20th of January, 1886, public traffic commencing on the 1st of February, 1886—a little over six years from the starting of the preliminary works.

The works were initiated by sinking two shafts—one at Liverpool, 15ft. in diameter, and about 170ft. in depth, to the bottom of the sump; and one at Birkenhead, 17ft. 6in. in diameter, and of similar depth. The distance between the quay walls on the two banks of the estuary of the river Mersey, at the points between which the tunnel passed under, was 1320 yards, the distance between the pumping shafts being 1770 yards. From each shaft the drainage heading was driven under the river towards the centre, rising with gradients of 1 in 500 and 1 in 900. This heading was at first carried on from both sides by hand, but the Birkenhead face was afterwards excavated by means of the Beaumont machine, which bored out a circular heading 7ft. 4in. in diameter. The speed of driving by hand had been between 10 and 13 yards per week, giving a 9ft. by 8ft. heading—a size large enough for working double roads. The heading of 7ft. 4in. diameter, produced by the Beaumont machine, required to be both heightened and widened before it could be used, in order to work "break-ups." The setting out was a matter of some difficulty, and was carried out with great precision. The headings met at 1115 yards from the Birkenhead working-shaft, and 639 yards from that at Liverpool, with an error of 1in. in meeting, and a maximum error of 2½in. at the centre from the true line, both lines being proved to diverge slightly to the south. The levels were transferred down the shafts by carefully checked steel tapes, and the final result was that when the headings met, on the 17th of January, 1884, a point which had been fixed as being 129·05ft. above datum, as levelled from Birkenhead, was found to be 129·04ft. above datum, as levelled from Liverpool. The drainage arrangements had proved very efficient, and resulted in the tunnel itself being remarkably dry. On the occasion of the opening, the tunnel was lighted by gas, and thousands of visitors walked through from end to end, without so much as seeing a drop of water, the only complaint being that it was slightly dusty.

The river tunnel was 26ft. in width, and, where in rock, was lined and inverted with brickwork in cement 2ft. 3in. in thickness, the two inner rings with headers being of brindle brick. The minimum amount of cover between the extrados of the arch and the bed of the river was about 30ft., and the depth of water above at high tide was 100ft. The tunnel was carried out by means of a heading driven through at all speed, and numerous break-ups, so that at one time work was proceeding from twenty-four faces, the whole being well drained. Additional shafts were sunk both at Birkenhead and Liverpool for winding purposes, and these were closed upon the completion of the works. The whole of the 320,000 cubic yards of rock excavated in the tunnel, and more than 60 per cent. of that excavated in the drainage heading, were taken out by hand labour—hand-and-hammer work. The land tunnels were of similar dimensions internally to those of the river tunnel, and were generally lined with 18in. of brickwork, no invert being added where the tunnel was in solid rock. The total number of bricks used in the lining of the tunnel and headings, and in the covered way, was 38,000,000.

The Hamilton-street and James-street stations were excavated in the solid rock, and being near the river were necessarily at great depth; the rails at James-street were about 90ft. and at Hamilton-square 100ft. below the level of the booking halls. The stations were 400ft. long by 50ft. wide by 32ft. high, and were arched with brickwork in cement, 2ft. 3in. in thickness, and lined, to a height of 12ft. above platform level, with white-glazed bricks, the subways being lined in like manner. The lifts, which had been manufactured by Messrs. Easton and Anderson, MM. Inst. C.E., were, it was believed, the largest yet constructed for passenger purposes. After careful consideration of different proposals, it was decided that, to secure safety, a direct-acting ram, working at a comparatively low pressure, should be adopted. This necessitated the sinking of wells, for the reception of the cylinders, into the red sandstone rock; and, as time was of great importance, it was decided to place the work at James-street, Liverpool, in the hands of Messrs. Mather and Platt, of Salford, whilst Messrs. Timmins, of Runcorn, undertook the sinking of those at Hamilton-square station, Birkenhead. In both stations there were three lifts, each arranged to accommodate 100 passengers at a time. The time occupied on the vertical journey was about forty-five seconds, so that a train-load of 300 passengers could be brought from platform level to the surface in one minute. The lift consisted of a room, or cage, 20ft. long, 17ft. wide, and 8ft. to 10ft. high, with seats on each side, and was fitted with handsome panelled sides of teak and American ash, and with a lantern roof surrounded by mirrors, with a central gas lamp. The lifts were severely tested by General Hutchinson, of the Board of Trade, on the 29th of December, with loads equal to about 140 passengers concentrated on one side of the cage, and they stood these tests most satisfactorily.

The ventilation of the tunnel and stations had been the subject of much consideration. The principle laid down was that fresh air should enter at the stations and "split" each way into the tunnel. By this means the atmosphere on the platform was maintained in a condition of purity. The air had then to travel towards a point midway between the stations, whence it was extracted from the tunnel by ventilating fans. The air drift was connected by means of sliding doors with the tunnel and the stations, so that the air could be extracted from any point desired. The fans were constructed on somewhat similar lines to those of the well-known Guibal fans, excepting that an important alteration had been made in the shutter. The fans were four in number; two of them 40ft. in diameter by 12ft. wide, and two 30ft. in diameter by 10ft. wide, one of each size being erected at Liverpool and at Birkenhead respectively. For the purpose of ventilation, the tunnel was divided into four sections, one of the above fans being allotted to each; but two fans at Liverpool and one fan at Shore-road, Birkenhead, could at any moment, through the medium of doors in the air headings and passages, be made to do each other's duty as well as their own, and by this means any complete stoppage in the ventilation of the tunnel was rendered impossible. The 30ft. fan erected at Liverpool ventilated the James-street station and the section lying between the said station and the terminus. This fan exhausted about 120,000 cubic feet of air per minute. The 40ft. fan erected in Liverpool ventilated the section of the tunnel lying between James-street station and the centre of the river. This fan exhausted about 130,000 cubic feet of air per minute. The 40ft. fan at Shore-road did similar duty to the 40ft. fan working at Liverpool, and ventilated the section lying betwixt the middle of the river and the Hamilton-square station at Birkenhead. The air exhausted by this ventilator was also about 130,000 cubic feet per minute. The fourth fan, of 30ft. diameter, exhausting nearly 200,000 cubic feet of air per minute, was erected in Hamilton-street, nearly midway betwixt Hamilton-square station and Borough-road station. The total yield of the four fans amounted to 580,000 cubic feet of air per minute, or about one-seventh part of the total cubic capacity of the tunnel. The stations were lighted with gas, as the author was of opinion that, so long as the smallest uncertainty existed as regarded the regularity of electric lighting, a railway company was not justified in employing electricity as a lighting agent, unless gas was also laid on, so as to be readily available in case of breakdown of the electric lighting machinery. The locomotives had been manufactured by Messrs. Beyer, Peacock, and Co., and the carriages by the Ashbury Carriage Company. Each locomotive was provided with a powerful steam brake, as well as with an automatic vacuum brake, and with the condensing apparatus as used on the Metropolitan Railway. They were designed for trains of 130 tons gross, exclusive of their own weight.

The company was now proceeding with the authorised extensions. The necessary junctions with the main line for these extensions had been already constructed, so far as excavation and brickwork were concerned. The work herein described, including the purchase of property, rolling stock, parliamentary and all contingent expenses, had cost about £500,000 per mile of double railway. Considering its special and somewhat difficult character, it had been remarkably free from accident. The inspector of the Board of Trade, Major-General Hutchinson, R.E., thus summed up his report upon it:—"In conclusion, I think it just to remark that great credit appears to be due to the engineers and contractors who have so ably carried out and brought to so satisfactory a conclusion this great and important work."

The joint engineers of the company were Mr. James Brunlees, past-president, and Sir Douglas Fox, M.I.C.E., assisted by the author; the resident engineer was Mr. Archibald H. Irvine, M. Inst. C.E., assisted by Mr. Ernest S. Wilcox; and the contractors were Major Samuel Isaac, and Messrs. Waddell and Sons, represented by Messrs. James Prentice and D. A. Davidson.

HYDRAULIC PASSENGER LIFTS.

The second paper read was "On the Hydraulic Passenger Lifts at the Underground Stations of the Mersey Railway," by Mr. William Edmund Rich, M. Inst. C.E. It was observed that a novel feature of the Mersey Railway was the introduction of large hydraulic lifts for conveying passengers and their luggage from the deep underground stations at James-street and Hamilton-street to the daylight stations at the street level above. At each station there were three lifts, which were worked quite independently of one another, and were each capable of raising 100 passengers at a time. The average journey was accomplished in from thirty to forty seconds and the three lifts working simultaneously were capable of raising a heavy train load of 300 passengers to the surface in about a minute. The lifts at James-street had a stroke of 76·6ft., and those at Hamilton-street a stroke of 87·7ft., and there was 50 per cent. more engine power at the former station; but in other respects a description of the arrangements at James-street would suffice. Each lift was of the direct-acting ram type, and was contained in a rectangular shaft 21ft. long and 19ft. wide, partly excavated out of the solid red sandstone rock, which stood well without lining, and partly enclosed in walls of brick in cement. This shaft descended to 8ft. below the lower hall floor, and a central boring 40in. in internal diameter was carried down 75ft. further. The cylinders which enclosed the ram were suspended in this boring from a large bell flange on the top length. They were 21in. in internal diameter, and were fitted with a hat-shaped leather at the top end for making the joint round the ram. The ram was 18in. in diameter and ½in. thick, and was constructed of mild steel lap-welded tubes in lengths of about 11ft. 6in. connected together with internal screwed ferrules 6in. long and 15¾in. in internal diameter. For extra security wrought iron rods 1½in. in diameter were carried up the centre of the ram, which at its top end entered the boss of a large forged steel cross, and was secured to it by the above rods and turned bolts. The cross was 11ft. long and 9ft. 6in. wide, and was forged by Messrs. Clay, Inman, and Co. from a single steel ingot. The ends of the arms were rivetted to girders, which were laid transversely beneath the lift cage, and extended beyond its sides to enable the counterweight chains to be attached at their outer ends. The ascending room or cage was a handsomely panelled wooden structure 19ft. 6in. long and 16ft. 6in. wide and 8ft. to 10ft. high, measured on the inside, with seats for twenty-four passengers at the sides, and a large gas lamp in the centre of the roof. It was founded on pitch pine floor joists 10½in. deep, which were strapped down to the iron girders above mentioned with iron stirrups. It was guided by four cast iron V-guide brackets, bolted to the ends of the cage girders, and bearing against four steel guide rails of a special section, which were fixed to the side walls of the lift space. Four similar rails guided the counterweights, which were suspended by 1⅛in. chains, which passed over pulleys at the top of the lift space, and at their other ends were attached to the extremities of the cage girders. Two chains 7in. apart were attached to each weight, and thus relieved the ram of transverse strain, if the load was concentrated near the front or the back of the cage. The lift starting-valve was a gun-metal slide, working over V-shaped ports, and was actuated by hemp hand ropes with wire cores, which passed through the cage on either side of the doorway, with stops on one rope for automatically closing the valve when the cage reached the top or the bottom floor. The lifts were worked by water at a low-pressure from a 10,000 gallon circular wrought iron tank, contained in a tower with its bottom at about 111ft. above the street level. The water was discharged during the down stroke into a waste tank of similar capacity with its bottom at 10ft. above the lower hall floor. The net effective fall was thus 176·5ft., or 76·4 lb. per square inch. The engine room floor was 27ft. above the lower hall, and contained three steel marine boilers and three pairs of high-pressure duplex pumping engines, each capable of raising 500 gallons per minute.

There were three 7in. mains from the tank to the several lifts, and these were connected to one another and to the several pumping mains in the engine-room, so that normally all would be open to one another; the pumps would automatically keep the top tank full by ball cocks and self-acting valves under it, and when a lift was working it would be supplied both from the tank and from the pumps simultaneously. At the same time the tank or any lift, pumping engine, or main pipe, could be shut off without stopping any other part of the system. The steam stop valves on the pumping engines were left wide open from morning to night, and their speed was entirely regulated by the ball valves in the top tank, and the starting valves on the lifts. When the tank was full and the lifts were quiescent, the engines stopped dead, but they started again at full speed directly any lift valve was opened. Up to the present moment the lifts at James-street had been worked direct from the pumps alone, as the tower for receiving the tank was not yet erected. The accumulator power in the top tank was equivalent to twelve journeys, and the top and bottom tanks being of equal size there was practically no waste of the water, which, getting greasy, economised lubricants and made the starting valves work easily. The internal cage floor area was 322 square feet, or 3·2 square feet per passenger. A dense London crowd occupied 1 square foot per head. The first cylinders were fixed at the end of August, and the lifts were severely tested by General Hutchinson, of the Board of Trade, and passed for work on the 29th of December, 1885. The total cost of the six lifts, with their attendant machinery, was about £20,000. They were designed and constructed by Messrs. Easton and Anderson, M.M. Inst. C.E., of London, to meet the specified requirements of Mr. James Brunlees and Sir Douglas Fox, M.M. Inst. C.E., engineers of the Mersey Railway, under whose supervision the whole of these works were carried out.

ON THE WORK DONE FOR THE PRESERVATION OF THE DAM AT HOLYOKE, MASS., IN 1885.*

By Mr. Clemens Herschel, C.E.

The paper opens with an account of the water power at Holyoke. The charter of the Hadley Falls Company was obtained in 1847, one of its purposes being the building and maintaining of a dam across the Connecticut. The first dam was intended as a temporary one, to serve as a protection during the erection of a more substantial one below it. It was not able to resist the force of the river, and was carried away a few hours after the gates were closed. The construction of this dam is not known to the author.

The second and present dam was begun and completed in the summer of 1849. It is 1017ft. long. At the ends are abutments of heavy masonry. Between these abutments it is composed of heavy timber crib-work, the surface on the upper side being inclined 21 deg. 45 min. to the surface of the river. The timbers are bolted to the rock bottom with about 3000 1¼in. iron bolts. The foot of the dam was protected with gravel covered with a mass of concrete. All open spaces were packed with stone to a perpendicular height of about 10ft. The gravelling in the bed of the river began 70ft. above the dam, and was continued over 30ft. or more of its sloping surface. The fall from the river above the dam to still water below is 59·9ft., there being a perpendicular fall of 30ft. The total cost is given at 150,000 dols. The chief engineer was Philander Anderson. The maximum height of water over the dam, from its completion to the present time, has been 12½ft. in 1862. Only 10ft. had been provided for in the construction. The dam is built on a ledge of red slate, which in places becomes a hard red sandstone. This dips down stream at an angle of about 30 deg. with the horizontal. In 1868 an examination showed that the fall, aided by logs, &c., had washed out the ledge in front of the dam to a depth of 20ft. to 25ft., and had in places worked back under the foot of the dam, partially undermining it. In 1868 to 1870 an apron was built down stream from the dam, its volume far exceeding that of the original dam. It was built of round logs laid so as to form bins 6ft. square, which were filled with stone to the top. This protected the dam from further undermining, but a new "pool" was soon excavated below the apron, which is now 20ft. to 25ft. deep at the deepest parts. The dam then continued to do its work until, in 1879, there appeared a well-defined whirlpool above its crest, and examination soon showed a break through the plank covering at that point. This and subsequent breaks were repaired by means of cribs, made like a box without top or bottom, the under side being cut to a bevel, so that when resting on the back of the dam the upper side would be horizontal. In 1881 there were two new breaks, which again broke through in 1882. There were no breaks in 1883, but in 1884 a large one appeared which could not be covered with the 20ft. by 35ft. crib of 1882. A crib, 40ft. by 45ft., was accordingly built, the whole being completed in nineteen days. Details of the operations of setting the cribs and repairing the breaks are given. One serious objection to this method of repairing the dam was the liability to make new breaks in repairing those already made. As the dam was all of the same age, the occurrence of much more serious breaks was probable, and the proper course for the future became a question for earnest consideration.

The first project was to sink cribs on the dam, cut through the covering, and fill it with gravel well washed in. Plant was accordingly prepared, and in December, 1884, the work of filling was begun, but owing to the severity of the weather no progress could be made, and the work was discontinued until after the spring freshets. This gave an opportunity for a careful study of the whole subject. This was made by the use of models, the use of which is earnestly recommended by the author as in many cases superior to drawings. The plan finally adopted was, by the use of cofferdams, to lay bare a space 20ft. by 100ft. next the crest of the dam, and remove the covering. Sheet piling was then carefully placed against the up-stream face of horizontal timbers of the crib-work of the dam, so as, with the solid course formed by the crossing of the timbers forming the "bins," to constitute a continuous line of sheet piling lengthwise of the dam. Gravel was then dumped each side of the sheet piling, and washed down until no more could be put in. The covering was then restored, and the coffer dams moved to the next section. In carrying out this plan, the gravel, *débris*, &c., on the surface of the dam had first to be removed for the placing of the coffers. The plan finally adopted for this was to have divers wash the material into windrows with a stream at 80 lb. to 90 lb. pressure through an inch nozzle. This was then removed by a very small clam-shell dredge. Three divers and the dredge finally cleaned 120ft. of dam in about four days. The author comments on the great value of employing divers in many classes of work under water. He insists on the use of a check valve in the helmets of divers, and of a telephone between diver and tender. Two divers were lost on the work, one of whom would have been saved by the use of a check valve. After the surface of the dam was cleared, the cofferdams were put in place, and the joints made tight by spiking on planks. With the aid of the floating derrick two coffers could be set in place in one day. Before placing the planks of the sheet piling, the "bins" were dug out, or the stone picked out by hand, as low as the water would permit, this being throughout several feet lower than the old stone filling put in in 1849. With the exception of driving the plank into the old filling about a foot, they were carefully set by hand and well braced against the opposite face of the bin. The bottom averaged from 25ft. to 28ft. below the crest of the dam. The gravel for filling on each side of the plank was from a pit about two miles away. It was shovelled into dump buckets which were carried on cars to the work, where it was dumped from the same buckets. The average cost for wages was 46·6 cents per cubic yard, about 15 cents of this being for railroad service. The gravel was washed down as dumped by water from three lines of hose tapped into the coffer dam. The total amount of gravel put in was about 13,000 cubic yards.

As a result of the work done, further breaks as heretofore understood are impossible or of no consequence; the timbers being encased in solidly puddled gravel, are permanently protected against decay, and the leakage has been reduced to about one-tenth of what it was before the break of 1884. The first half of the dam was repaired in about three months, the last half in one month, and usually on a work of this sort the author considers triple the speed at the end from that at the beginning generally attainable. Electric lights were used on the work, and proved of the greatest value. No difficulties were encountered in closing the last section, this being perhaps due to the fact that that side of the river had filled in much more than the other shore or the middle part. It was well-known, too, that the leakage of the middle 200ft. of the dam was much worse than the rest. The cost of the work is estimated at about 65,000 dols., including the cost of plant. It cannot be precisely stated, because the repairs of 1884 and the break of 1885 were charged to the same account.

The author deduces the following as the lesson of 1849 to 1886 in the construction of wooden dams:—(1) A wooden dam should never be left hollow, nor should it be filled with stone. Let a row of sheet piling be put in in some proper position, then puddle in gravel. (2) In crib work two timbers should never be butted over another of the course next underneath. (3) Never substitute masonry for the frame of the dam next to the abutment. (4) The back of the dam should be guarded from such abuse as the dropping of a 4-ton stone upon it. (5) The shape of a dam should always be chosen with a view to preventing the excavation of the river bed, and the formation of a pool below the dam. In this connection the author made experiments with models one-twelfth full size to determine the proper form for a new stone dam at Holyoke. The ogee form gave the best solution of the problem. A reverse incline is necessary at the foot of the dam sufficient to destroy the acquired velocity of the water, and project it in a horizontal

* American Society of Civil Engineers.

direction parallel to the bed of the stream, or the bed of the stream should be protected. The author learned, while writing this paper, that the Croton Dam is of this form. There is also a dam of an ogee shape in Spain.

THE ELECTRIC LIGHTING ACT (1882) AMENDMENT (No. 3) BILL.

THE following is a petition against the above, and in favour of "The Electric Lighting Act, 1882," Amendment (No. 1) Bill, which has been addressed by the Institution of Civil Engineers "to the Right Honourable the Lords Spiritual and Temporal, in Parliament assembled":—

The Humble Petition of the Institution of Civil Engineers, incorporated by Royal Charter "for the general advancement of Mechanical Science, and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a Civil Engineer, being the art of directing the great sources of power in nature for the use and convenience of man,"

Sheweth:—

1. That in the year 1882 an Act of Parliament was passed to apply to all Provisional Orders or Acts relative to the distribution of electricity for lighting and other purposes.

2. By Section 27 of the said Act it was enacted that at the expiration of twenty-one years, or such shorter period as might be provided in the special Act, and within six months after the expiration of every subsequent period of seven years, or such shorter period as might be provided in the special Act, any local authority within whose jurisdiction the area of the undertaking, or any part thereof was situated, might require the undertakers to sell their undertaking, or part thereof, upon the terms of paying the then value of all lands, buildings, works, materials, and plant suitable to and used for the purposes of their undertaking, and in the event of non-agreement the price was to be determined by arbitration; but the arbitrator was forbidden to allow any payment in respect of compulsory purchase, or of goodwill, or of any profits which may, or might have been, or be made from the undertaking, or of any similar considerations.

3. That the effect of the foregoing conditions has been entirely to stop, during the four years since the Act has been passed, the application of private capital to the distribution of electricity from a central station to householders, manufacturers, shopkeepers, and others desirous of receiving it as a source of illumination; it being impossible to find persons of means who would embark their capital in undertakings subjected to such conditions—conditions which must of necessity when enforced—as they would be if the undertaking were prosperous—return to the shareholders only a small portion of the capital which they had invested.

4. That your petitioners embrace among their members persons practising in every branch of civil engineering, which is defined in their charter to be the art of directing the great sources of power in nature for the use and convenience of man, thus including electrical engineering; and that they are desirous, in the interests of industry and of the growth of a new and useful application of science to the purposes of daily life, that electrical lighting should have a thoroughly full and fair trial.

5. There are now before your Lordships' House three Bills, Nos. 1, 2, and 3, each of which purports to be an Amendment of "The Electric Lighting Act of 1882."

6. No. 3 Bill—the one brought in by Lord Houghton—does not vary the Act of 1882, except by an extension of the time before the compulsory right of purchase would arise, from the twenty-one years of the Act of 1882 to thirty years, with a further period of twelve years should the local authority agree, and by the extension of the recurrent periods of option from seven years to ten years.

7. Your petitioners are convinced that such a measure would not cure the defects of the existing law, and would not be successful in attracting capital to an electric light undertaking, which must be essentially one of development. Unlike the case of the construction of a railway between two points, or of a canal between two points, or of the making of a dock, cases where the work is done as a whole and where the capital is needed, and is called up at once; an electric light undertaking is one wherein, at the outset, only a comparatively small portion of the capital can properly be utilised, and it would not be until after a lapse of years, when persons had been educated to use the electric light, and were willing, for the sake of its advantages, to discard the gas fittings for which they had already paid, and to incur the expense of electric light fittings, that there would be such a large or general use of electricity for lighting purposes as to need the expenditure of further capital.

8. That with such a clause as that proposed by No. 3 Bill—a clause which merely defers the time of compulsory purchase—it would be impossible to obtain this extra capital as needed; because even if at first persons would subscribe for a probable enjoyment of thirty years, no one would be found to embark money after the lapse of a few years, when the term of enjoyment was so much shortened.

9. No. 2 Bill ameliorates Section 27 to some extent, but the Bill—No. 1—now before your Lordships' House proposes to repeal the Act of 1882 altogether, and to assimilate the legislation in respect of electric light undertakings to that legislation which of late years has prevailed in respect of gas undertakings, and has proved so beneficial to the public, while yielding security of property to those who embark their capital. Bill No. 1 provides that the obligations upon the distributors of electricity shall be the same as those which are imposed upon gas undertakings; that dividends shall be regulated upon the sliding scale, by which there is a direct incentive to the undertakers to sell the commodity at the lowest possible price consistent with a profit; and further, that all future capital shall be issued under an auction clause, thus insuring that the consumers shall not be liable to pay any greater amount as dividend than is fairly demanded by the risk of the undertaking.

10. Your petitioners desire to point out that the new industry of electric lighting has been, by the Act of 1882, and would, by the amended Bill No. 3, if it were passed into law, be subject to burdens which render it impossible to give a mode of lighting that has so much to commend it a fair chance of development, and therefore prevent the establishment of an industry that would give householders and others an option as to the mode of lighting from an external source of supply—an option they do not now possess.

Your petitioners therefore humbly pray your Lordships that the said Electric Lighting Act (1882) Amendment (No. 3) Bill may not be allowed to pass into law, but that the Electric Lighting Act (1882) Amendment (No. 1) may pass into law, and that this petition may be referred to the Committee of your Right Honourable House to whom those Bills have been referred, or that such other relief may be given to your petitioners on the premises as your Lordships shall deem meet.

And your petitioners will ever pray, &c.

Sealed with the seal of the Institution of Civil Engineers, this 29th day of April, 1886, in the presence of JAMES FORREST,
Secretary to the Institution.

THE number of canals, including canal navigations, now under the control of railways is, according to Mr. Mundella, 39, with an aggregate length of 1436 miles. There are also 40 other canals with an aggregate length of 1592 miles, but how far any of these navigations are indirectly under the control of railway companies he is unable to state. In the appendix to the report of the Select Committee on Canals in 1883, at pages 215 and 217, will be found a statement of the names and lengths of the canals and canal navigations under the control of railway companies, and the respective periods when they came under the control of those companies.

LAUNCHES AND TRIAL TRIPS.

ON Thursday, the 6th inst., the Barrow Shipbuilding Company launched from its yard the first of two large steamships building by it for the Pacific Steam Navigation Company of Liverpool for its trade between Liverpool and Valparaiso. The vessel is 460ft. in length, 49ft. in breadth, and 38ft. 3in. depth moulded, and has a gross register tonnage of about 6500 tons. She is rigged with four masts. The hull has been constructed on the longitudinal double bottom principle and fitted with four complete closed-in decks all fore and aft, and a promenade deck extended to the ship's side. Her superstructures consist of a short poop and forecastle and a long range of midship deckhouses. The deck erections and various 'tween decks have been fitted up to accommodate 124 first, 54 second, and 412 third-class passengers, as well as for officers and crew. The saloons and cabins will be furnished in the best style, panelled in hard wood and upholstered in a most luxurious manner by Messrs. A. Blain and Co. of Liverpool, and will be electrically lighted by 400 incandescent lamps. All passenger spaces, saloons, and state rooms will be ventilated by machinery on Mr. D. C. Green's principle, and the most ample provision has been made for their convenience and comfort. She will have six steam winches for the purpose of loading and discharging cargo, made by Messrs. Waddington and Longbottom, of Barrow; a steam steering engine, by Messrs. Muir and Caldwell; Hastie's patent screw steering gear, Clarke, Chapman, and Co.'s steam windlass for working the anchors. The vessel will also be fitted with refrigerating chambers for carrying meat, and the refrigerating machine will be capable of cooling 70,000 cubic feet of air per hour. The ship will be propelled by inverted direct-acting triple expansion engines to indicate 6000-horse power, the diameter of the high-pressure cylinder being 40in., intermediate cylinder 66in., and low-pressure cylinder 100in., with a stroke of 6ft., adapted for a working pressure of 160 lb. per square inch. The ship has been built under special survey of both Lloyd's and Liverpool Underwriters, and will receive the highest class in those registries.

On Saturday morning last the Barrow Shipbuilding Company launched two small vessels for Messrs. R. Singlehurst and Co., Liverpool. The vessels were named the Minnie and the May. The launches took place immediately one after the other, and formed a very pretty sight, and the vessels started immediately for Liverpool.

On Monday, the 10th inst., the steam tug Alert, built for the Severn Canal Carrying, Shipping, and Steam Towing Company by Edward Finch and Co., of Chepstow, ran a very satisfactory trial trip down the Channel, and after steaming for several hours at the rate of 11 knots, entered Sharpness Docks. Her dimensions are:—Length, 60ft.; breadth, 13ft.; depth, 7ft. She is fitted with compound surface-condensing tandem engines, built by Edward Finch and Co., cylinders 11 and 19 by 14in. stroke, with a boiler designed for a working pressure of 90 lb.

The Union Steamship Company's mail steamer African, a very fine steamer, which has been built on the Tees by Messrs. Raylton Dixon and Co. for the Union Steamship Company, of Southampton, for their intercolonial service from Cape Town to Natal, has just been completed and opened for inspection. The vessel is of the following dimensions—253ft. by 33ft. 3in. by 24ft. 7½in.—and is built of Siemens-Martin steel from Eston Steel Works of Messrs. Bolckow, Vaughan, and Co. In order to secure greater strength, although built of steel, the scantlings are in excess of that required for Lloyd's highest class of iron vessels. Her gross register is 1372 tons, and her dead-weight capacity is 1200 tons, but as the cargo to be carried generally consists of light goods, she is fitted with ballast of iron dross made solid with concrete in the bottom, which gives her additional stability and strength. She is schooner rigged, with pole masts of steel, and with one yard on her foremast, which gives her a smart and rakish appearance. The engines are on Wyllie's triple expansion system, by Messrs. T. Richardson and Sons, of Hartlepool. The cylinders are 21, 34½, and 55½ by 36in., working direct on to three cranks. These engines will develope over 1200 effective horse-power, and are intended to propel the vessel at a speed of about fourteen miles an hour. Her official trial trip is to take place next week in Stokes Bay.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, May 1st.

JAY GOULD, in the course of a long interview with a newspaper reporter to-day, says that the widespread labour movement is due to the agitations of the Knights of Labour, which have been stirring up strife and discord; that this organisation has entered upon a too great undertaking; that the Missouri Pacific Railway Company has been materially benefitted by it in being able to rid itself of men who were a constant source of annoyance; that the plan of arbitration, as suggested by President Cleveland, is wise and will be accepted; that the true mission of labour organisation is to educate and not to strike. The New York Chamber of Commerce, representing over 100,000,000 dols. worth of capital, passed resolutions this week recognising the right of labour to organise and strike, but condemning all violent measures, and urging the establishment of a system of arbitration for the settlement of disputes without strikes. Strong combinations of employers are being formed throughout the ten New England and Middle States, for the purpose of rendering mutual assistance in case of trouble. The necessity for organisation is being recognised in Western States, and movements are on foot looking to the coming together of employers with like interests. The nine or eight-hour day will be inaugurated on Monday, and it is believed in manufacturing circles that the agitation will continue throughout the summer, probably unsettling calculations to a considerable extent. Compromises have been made on nine hours, with proportionate reductions of pay, covering about three-fourths of the striking labourers. The other fourth insist upon a reduction to eight hours, or full pay for reduced time. In trade conditions nothing of special interest has transpired. Manufacturers, jobbers, and consumers are waiting the result of the change from the ten-hour day to the shorter day. In railroad circles reports are conflicting concerning the alleged improvement in traffic. The Texas and Pacific organisation has been completed. The Reading Railroad affairs still remain in an unsettled condition. The friends of both of the contending parties in the reorganisation are looking for the announcement from Mr. Gowne every day, which will be acceptable to all parties. In the event of his inability to please both sides, the whole matter will probably be thrown into court, and lawyers, receivers, and the sheriff will have a holiday. An important meeting of the anthracite coal interests was held Thursday afternoon, at which all the companies were represented, to arrange details for the opening of the summer trade to the West. The Western demand, as well as the Southern demand, is still increasing, and the companies desire to avoid any unnecessary competition. Work on the South Penn line, which is to be a competitor of the Pennsylvania system between New York and Pittsburgh, will begin June 1st. The Baltimore and Ohio Company is pushing its parallel line from Baltimore to Philadelphia with the utmost activity, thus being another competitor to the Pennsylvania system. Competitive railway lines are projected between Chicago and points in the North-west, and the continuance of freight rate wars is probable.

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

(*From our own Correspondent.*)

THE condition of the sheet trade still attracts most attention. The market for this iron remains against makers, and it is difficult to obtain any rise upon the late minimum. Nevertheless some few exceptional firms are making an attempt to get an advance, and these state that they will now only book orders at a 5s. per ton rise.

The firms who have put their sheet mills to a stand for the present are Messrs. Southern, of Walsall, and Messrs. Groucutt and Sons, the Bilston Iron Company, and Messrs. East, all in the Bilston district. With a view of strengthening prices, Messrs. Onions, too, who are running six mills at Moxley, have laid off two mills at Greet's-green. The ironworkers are very reluctant to consent to any revision of wages, but if trade continues to fall they must agree to some reduction if they are to get any wages at all. The bulk of the business has still to be done at the old prices. Strong makers are quoting £6 5s. for doubles and £7 to £7 2s. 6d. for lattens; but some firms, who are determined to keep their mills going, are currently reported as accepting orders at £6 per ton.

The position is rendered increasingly troublesome by growing competition from the North of England and from Scotland. Scotch doubles can now be delivered into this district at £5 17s. 6d. per ton, and Scotchmen are taking orders from London galvanising firms which previously came into this district.

It is as yet too soon to form any definite opinion of the effect upon the demand for best iron of the recent reductions. Still, Messrs. Hingley and Sons and a few other of the best houses are better employed. At the Earl of Dudley's Round Oak Works steel strip for boiler tubes is being rolled for the Admiralty and also rivet iron for the same department.

A slight error was in my quotations last week of Corngreaves iron. The proper figures are:—Best Corngreaves bars, £6 5s.; composite bars, £8 15s.; Best Corngreaves rods, £6; Best Corngreaves plates, £7 15s.; tank plates, £7; Best Corngreaves angles, £6 15s.; Best Corngreaves tees, £6 15s.; and Best Corngreaves hoops, £6 15s. per ton.

The effect upon unmarked iron prices of the reduction in branded iron has not been conspicuous. Makers declare that it is manifestly unfair to ask them to make further concessions when prices have for a long time been steadily falling.

As illustrating the current competition, large sized plates for working up are now coming into this district from Middlesbrough at £5 10s. delivered, equal to £4 15s. at makers' works. Local merchants are supplying to London galvanisers tank sheets for flanging, of 8ft. 6in. long and up to 48in. wide, and from 4 to 16 w.g., at £6 per ton. Sheets are brought from Newcastle-on-Tyne, and the makers will deliver them into the Thames for £5 16s. 3d. per ton. Similarly local merchants are buying good qualities of North Staffordshire bars of ordinary size at £5 7s. 6d., delivered in London. Orders for common bars and other descriptions for shipment continue to find their way to Belgium in considerable numbers.

High testimony to the quality of Staffordshire basic steel blooms is just now borne by certain of the sheet makers. They are greatly pleased with the soft nature of the material, upon which there is hardly any more work than in rolling iron. In this particular it is declared superior to some Siemens-Martin steel, and with which there was a good deal of waste, the sheets sticking together in consequence of their hardness. Under these circumstances, perhaps, the outlook of the new basic steel works which is to be established at Earl Granville's, in North Staffordshire, are more satisfactory than some ironmasters are willing to admit.

The galvanised iron and engineering firm of Morewood and Co., Birmingham, Soho, and London, which has been in business for over thirty years, and which succeeded to the trade of the original patentees of galvanised tinned iron, has been converted into a private limited liability company, with a capital of £250,000. None of the shares are offered to the public.

Prices of high-class pigs are fairly sustained, particularly for cold blast iron, which is in demand for chilled rolls, but the medium sorts fluctuate in value from 42s. 6d. down to 35s., and common cinder iron is selling in some cases under 30s., though most of the makers quote 30s. to 32s. 6d.

The Committee of the South Staffordshire Railway and Canal Freighters' Association's report details the considerable reductions which have been obtained from the railway companies during the past year, and state that they will continue to urge these matters upon the railway companies. Mr. Alfred Hickman, M.P., has been re-elected president, and has been desired to communicate with the companies with a view to obtaining the removal of the restrictions under which the recent reductions in finished iron rates apply to no lots smaller than 10 tons.

Much gratification is finding expression here at the conclusion of the new commercial treaty with Spain. It is confidently believed that the new state of affairs will lead to an enlarged business for this district.

The arrangements for supplying compressed air power to machinery users in Birmingham are proceeding satisfactorily. Contracts have now been placed by the company for the provision of such buildings, machinery, and mains, as will be needed for a supply of 6000 indicated horse-power. About eight miles of wrought iron mains, some of them of 2ft. diameter, will at once be laid. The company has already applications for nearly 4000-horse power. It is hoped that the contracts which have now been given out will be completed in a year's time, but an attempt is to be made to complete a portion of the scheme in time for the visit of the British Association. The ground to be first built upon has been laid out for works capable of 15,000 indicated horse-power, but only a section will be at present undertaken. The compressing engines will be in six sets, each set of 1000 indicated horse-power. They will be vertical triple expansion condensing engines, and will actuate directly six single-acting air cylinders. Each set of engines and air cylinders will be capable of delivering 2000 cubic feet of air per minute at 45 lb. pressure. The nineteen boilers will be fired by gas, generated in twelve Wilson producers. The air is to be supplied to consumers by meter. It has been suggested that a useful development of the project is possible if the power be applied to the production of electricity for private installations. The chief engineer is Mr. Sturgeon, C.E., who is in communication with Mr. Arthur Lupton, C.E., the engineer for the compressed air scheme in Leeds.

At a conference of traders and manufacturers held in Birmingham, the mayor, Alderman Martineau, presiding, the Railway Traffic Bill was considered. The great value of the Bill to inland traders was alluded to by several speakers. A vote of thanks to Mr. Mundella was passed, and a resolution in support of the Bill was adopted. Sir F. Knight expressed his belief that a scheme for widening the canals to London would be eventually carried.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—"Continued depression" has been so long the burden of my notes with regard to the condition of all branches of the iron industry in this district that it has become a painfully monotonous occupation to record anything concerning the course of trade. The same depression, with no prospect of improvement, is still the condition of trade here; the actual requirements of consumers continue of so meagre a character that practically no present business of any weight comes upon the market, and the small orders that are given out are competed for so keenly that prices are kept down to the lowest possible point, with a persistent weakening tendency that encourages buyers to purchase only from hand-to-mouth. The excessively low prices at which iron is offered by some needy sellers seem to make buyers in some instances even exceptionally cautious about placing out orders of any importance for long forward delivery, apparently owing to an apprehension of possible contingencies operating against the fulfilment of the contracts when the iron might actually be wanted. This feeling occasionally induces buyers, when they have orders of any weight to place for extended delivery, to pay even a slight advance upon the lowest current rates if they are satisfied that the deliveries of the iron can be absolutely guaranteed, which may be taken, not, unfortunately, as an indication of really better prices ruling in the open market, but of the prevalent forebodings as to the ultimate result of the present ruinously low prices to some of the makers of iron whose position is known to be already perilously weakened.

There was an extremely quiet iron market at Manchester on Tuesday. For pig iron very little inquiry was reported, and the actual business doing was so small that prices were scarcely tested. For local and district brands quotations were nominally about the same as last week, Lancashire averaging about 37s. to 37s. 6d., less 2½, and some Lincolnshire brands still quoted about the same figures for delivery equal to Manchester, but with sellers of both Derbyshire and Lincolnshire iron open to accept fully 1s. to 1s. 6d. per ton under these prices. But even at the very lowest figures current in the market I could hear of little or nothing doing. In outside brands the tendency of prices was lower, and in the best named brands of foundry Middlesbrough makers, who have been holding out for 39s. 4d. net cash delivered equal to Manchester, are now prepared to accept 6d. and in some instances 1s. per ton under this figure if orders could be secured.

Hematites still meet with little or no inquiry, and prices remain extremely low at 50s. to 50s. 6d., less 2½, being about the average figures at which ordinary No. 3 foundry qualities could be got delivered into this district.

In the finished iron trade business continues extremely slow, and works generally are only partially employed, whilst prices remain quite as low as ever. For bars, £4 17s. 6d. to £5 per ton remain about the average figures for delivery into this district, but I have heard of an order for spoke bars being placed at under £4 17s. 6d. In the hoop trade the prices ruling are so excessively low that the attempt to form a syndicate in the United States to keep the American orders for cotton ties in the hands of local makers seems to have practically fallen through owing to the much more favourable rates at which they can be placed here, and I understand that something like the usual orders are being given out to English makers, who are delivering cotton tie hoops at Liverpool at under £5 7s. 6d. per ton. The sheet trade is excessively dull, and prices are cut lower than have ever been known before. For the better class of North Staffordshire qualities it is difficult to get £6 10s. per ton delivered here, and local makes can be bought at less.

The condition of the engineering trades shows no improvement, and at many of the works in this district hands are being suspended or the men are only being kept employed week on and week off.

The important question of the fracture of safety lamp glasses through varying temperature or other causes was under consideration at a meeting of the Manchester Geological Society held in Wigan on Friday last. Mr. H. Hall, Inspector of Mines, pointed out that after the elaborate and exhaustive tests to which of late safety lamps had been subjected, mining engineers might almost hope to be now fully acquainted with the peculiarities of the different types of lamps; but the question of how a particular class of lamp might bear the wear and tear of daily use was a most important one, as, however theoretically safe such a lamp might be, any serious failure in the above respect must be fatal to its general introduction. Up to within the last few years mine officials had looked somewhat askance at the glass lamp, but recently it had been very largely introduced into mines, and, as compared with the gauze lamp, there was no question as to the increased safety it afforded. There was, however, the liability to fracture, and of the glass flying when subjected to rapid expansion through heat or contraction through cold. In order to test whether there was any serious danger in the use of safety lamps in the construction of which glass was largely used, he had collected statistics with reference to the fracture of glasses in safety lamps in actual use in several collieries. He did not claim that these statistics were either complete or conclusive, but they appeared to make it sufficiently clear that this question of the fracture of lamp glasses was an important one which required more light to be thrown upon it. At present, and pending further inquiry, they might assume the life of a glass to be something less than a working year, and that in a mine working 500 lamps, at least one lamp each day would be found to have been rendered actually unsafe either from fracture by a blow or through the glass flying by contraction or expansion on account of varying temperature. Although this might not at first sight appear to be a very serious matter, yet, when we bear in mind that where a fracture occurred through changing temperature, there was little chance of its being discovered until the end of the day, when the lamp was taken to pieces in the lamp cabin, we must feel that there was a danger which ought, if possible, to be remedied. The principal causes of glass cracking appeared to be too tight screwing into position, and this was more especially the case if the glasses were not exactly the same height over their whole circumference. Another cause was imperfect annealing. Mr. Hall urged that the proper annealing of the glasses should be carefully attended to, and that in all cases washers of asbestos to pack the glasses with should be used. In the discussion which followed, several mining engineers said they had found the proportion of glasses fractured in the lamps used in their mines to be very small, and these fractures were not to such an extent as to create any real element of danger. Mr. J. L. Hedley, inspector of mines, pointed out that the fractures were most numerously found in glasses of imperfect manufacture, and this was a question for the makers.

In the coal trade a very dull tone characterises the demand for all descriptions of round coal, especially the commoner sorts for steam and forge purposes, and prices are weak, there being still underselling in the market, notwithstanding the reductions at the commencement of the month. Engine classes of fuel are moving off fairly well, and although the lower qualities are still plentiful in the market, the lessened quantity of house fire coal now being screened is causing the best sorts of slack to get rather scarce, and for these prices are hardening, advances of 3d. to 6d. per ton upon late rates being already announced in some instances. At the pit mouth, best coal averages 8s. 6d.; seconds, 7s. to 7s. 6d.; common coal, 5s. to 5s. 6d., with as low as 4s. 9d. taken in some instances; burgy, 4s. 3d. to 4s. 9d.; ordinary slack, 3s. to 3s. 6d.; and best sorts, 3s. 9d. up to 4s. 3d. per ton.

Barrow.—There is a steady tone in the hematite pig iron trade, and the business done during the week shows an improvement on recent experiences, although the actual sales are not nearly so heavy as the demand. Makers are endeavouring as far as possible to restrict the output, so as to resist the attempt on the part of buyers to bring down prices to a lower point than that which is occupied at present. As a consequence, the orders booked at present are not large, but the fact that there is such a spirited demand must necessitate the placing of orders on a large scale at an early date.

Prices are firmly held at 42s. per ton net at makers' works for mixed numbers of Bessemer iron, prompt deliveries, and 41s. per ton for forge and foundry qualities No. 3. Orders have been placed for large consignments of inferior qualities of iron at less than 40s. per ton, but these are instances only in which needy sellers have found it necessary to dispose of their surplus stocks. The production of the furnaces is very considerable, representing 25,000 tons per week, but it is noteworthy that only half the furnaces are in blast, there being only 44 now engaged in the production of pig iron. Stocks remain very large, and may be computed at not less than 250,000 tons, but in the event of some better understanding being arrived at between buyers and sellers, these stocks would soon be disposed of, and lead the way to an increased production of pig iron.

The steel trade is better employed, and there is an apparent briskness in every department. The works, in fact, are in full employ, the only weak point in the trade being the poorer demand which has sprung up for ship and boiler plates. Engineers are not well off for orders, except in the marine department, and even there the orders for mechanical appliances are more numerous than those for ships themselves.

Iron ore finds a poor market, and although prices remain at from 8s. 6d. to 11s. per ton, there is a small inquiry and a slow business. Coal and coke is in better demand, at rather firmer prices. The shipping trade is better employed all round.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE Board of Trade returns for April continue to be fairly satisfactory with regard to two of our principal industries. Last month the value of hardware and cutlery exported to foreign countries and colonial markets was £233,994, as compared with £219,871 for the corresponding month of 1885. Russia and Germany are both decreasing markets, but not to any great extent; the Argentine Republic has fallen from £7046 to £6991, and British North America from £11,184 to £10,565. These four are the only markets which show a decrease. Holland has increased from £5900 to £6382; France, from £11,840 to £12,123; Spain and Canaries, from £6279 to £8134; the United States, from £18,100 to £24,981; foreign West Indies, from £2269 to £4391; Brazil, from £8933 to £10,154; British Possessions in South Africa, from £3226 to £3583; East Indies, from £20,564 to £23,229; Australasia, from £44,818 to £50,078. Pig iron has kept about the same with regard to the total volume of trade, the value exported last month £185,889, or about £6000 more than for the corresponding period of 1885. The United States shows a remarkable increase, viz., from £33,831 to £82,841. The value taken by the United States last month exceeds that of April, 1884, by over £21,000. In bar, angle, and bolt there is a fall on the month, as compared with April, 1885, the respective values being £92,155 and £127,349. The decrease in the trade with British East Indies is mainly responsible for the decline—£10,058 last month against £31,188 for April, 1885—though British North America has also decreased from £14,341 to £5741. The United States has tripled its business, though the gross value is only £4049.

Steel rails again show a serious attenuation. Russia, Germany, Egypt, and Mexico have taken more. Sweden and Norway have fallen from £5344 to £4555; Spain and Canaries, from £5613 to £31; Brazil, from £4884 to £4741; the Argentine Republic, from £21,346 to £9000; Chili, from £1125 to £105; Peru, from £2617 to £153; British North America, from £9669 to £855; British East Indies, from £74,105 to £51,373; Egypt, which was *nil* last month, took a value of £45,617 in Aprii, 1885. The increasing markets are the United States, from £13,616 to £36,392; Italy, from £416 to £13,336; British Possessions in South Africa, from £382 to £3243; and Australasia, from £34,291 to £38,331. The total value for April was £170,476, against £245,161 for April of 1885, which was a decrease of £25,000 on April of 1884. Railroad of all sorts was exported last month to the value of £285,018, against £372,370 for April, 1885. Italy and the United States were again the chief increasing markets.

Steel, unwrought, is still improving, the value sent abroad last month being £109,738, against £85,812 for April, 1885. France has fallen from £8662 to £7354; but the United States shows a gratifying increase from £15,327 to £45,829, which is £12,000 more than April of 1884. In hoops, sheets, and plates the United States has almost tripled its business. Indeed, the revival of the demand from the States is the feature of the returns for the month, and ought to have a specially favourable influence on Sheffield trade, though the competition for the American business is now excessively keen.

The Marquis Tseng, the Chinese Ambassador, accompanied by his *suite*, visited the works of Messrs. John Brown and Co. on Tuesday, and on Wednesday visited Messrs. W. Jessop and Co.'s Brightside Steel Works, afterwards returning to London.

Stagnation in the iron and coal trades is causing several works and pits to be temporarily closed in the immediate neighbourhood. In some districts the miners have only had two days' work a week during the present year.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Cleveland pig iron trade does not improve. At the market held at Middlesbrough on Tuesday last but little was done, and in some cases merchants were content to accept 29s. 6d. per ton for No. 3 g.m.b. for prompt delivery. This is 3d. per ton less than they were willing to take a week previously; nevertheless, there were not many buyers forthcoming, and transactions were few and unimportant. Makers have now become reconciled to sell at 30s. per ton for prompt delivery, and in some instances they have not refused 3d. less than that figure. The leading makers are not, however, in urgent need of orders, and they, for the most part, keep out of the market. The demand for forge iron continues exceedingly poor, notwithstanding that the price has fallen to 28s. 9d. per ton.

Warrants are quoted at 30s. per ton, but they are by no means in demand.

The stock of pig iron in Connal's Middlesbrough store amounted on Monday last to 225,772 tons, which represents an increase of 3490 tons during the week.

Some heavy shipments of pig, and also of finished iron, were made during last week. On Thursday no less than 9090 tons of pig iron were shipped. The total quantity for the first ten days of this month was, however, 22,345 tons, which is only a little more than during the corresponding portion of April. The manufactured iron shipped during the same time was 17,053 tons.

Finished iron makers are in no better position than they have been for some time past, and buyers are not to be tempted even by the present unprecedentedly low prices. The steel makers are fairly well employed, and at some of the steel works orders have been obtained which will suffice for several weeks. Prices remain unchanged.

Messrs. Bolckow, Vaughan, and Co. have secured a large order for steel rails and sleepers for a new Indian railway to be laid down to a gauge of 5ft. 6in.

The Cleveland ironmasters' statistics for the month of April were issued last week. They set forth that out of a total of 156 blast furnaces in the district, ninety-four are in operation. The make of pig iron of all kinds was 188,709 tons, or a decrease of 26,696 tons in comparison with the output for March. This decrease is accounted for by the stoppage caused by the recent wages dispute. The stocks in the district have now reached a grand total of 651,860 tons, which is an increase of 10,239 tons over and above the returns for the previous month. The value of this accumulation is within a very little of a million pounds, and the cost of holding it, including rent of ground occupied and interest on the value at 5 per cent., is 2s. per ton, or nearly £100,000 per annum. As though this heavy and unprofitable tax were not sufficient, ironmasters are still making very much more than there is any demand for, and so adding month by month to the accumulated stock. Surely there must soon be an end to so suicidal a policy. Artificial restriction by means of a combination with a mutual understanding seems virtually impracticable, and the only probable course of events is that those should blow out their furnaces who are strong enough and wise enough to take that course, or otherwise those whose necessities compel them to do so. There is, perhaps, yet one other alternative, which is, that prices should be lowered until a point is arrived at, where the excessive make of Cleveland pig iron is able to displace the brands of pig iron now currently in use from other districts. This, however, is a desperate game to play at. It is a battle of purses, and who shall say what firms, what individuals, or what districts would survive if the fight were carried to extremes and no quarter given. Meanwhile it is worth while to consider what persons really own the million pounds' worth of Cleveland pig iron now in stock, and are consequently paying the £100,000 a year in interest and rent involved thereby. Is it the smelters themselves, or is it merchants, or bankers, or speculators, or some of each? Whoever they may be, do they ever expect to see their principal and interest back again? And if so, when and how? Again, are their prospects of avoiding loss and securing gain so good that smelters are justified in continuing to stock at the rate of 10,000 tons per month—an increase which would have been nearly 37,000 tons, but for the accidental circumstance of a strike, which is now over and not likely to occur again?

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE past week has been one of marked depression in the iron market, the speculative department of which has been entirely devoid of animation. Although the shipments of pigs are not so good as they were in the preceding week, yet they are not altogether discouraging, the quantity sent to Canada in particular being much larger than usual. The total shipments were 9735 tons, as compared with 10,282 in the preceding week, and 10,779 in the corresponding week of 1885. Since last report one furnace has been put out at the Quarter Ironworks, the total now in blast being ninety-four, as against ninety-two at the same date last year. The increase in stocks continues on an extensive scale, the week's addition in the Glasgow warrant stores being 5000 tons.

Business was done in the warrant market on Friday from 38s. 5d. to 38s. 3d. cash. Monday's market was depressed at 38s. 2d. to 38s. 1d. The feeling was a shade more satisfactory on Tuesday, when the quotations were 38s. 1½d. to 38s. 3d. cash. Wednesday's market was quiet at 38s. 4d. to 38s. 1½d. cash. To-day—Thursday—the quotations were 38s. 1d. to 38s. 2½d., closing at 38s. 2d. cash.

The demand for makers' iron being comparatively poor, current prices are quoted rather lower, as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 42s. 6d.; No. 3, 40s. 6d.; Coltness, 47s. and 42s. 6d.; Langloan, 44s. and 41s. 6d.; Summerlee, 45s. 6d. and 41s. 6d.; Calder, 46s. 6d. and 41s.; Carnbroe, 42s. and 39s. 6d.; Clyde, 42s. 6d. and 39s. 6d.; Monkland, 39s. and 36s.; Quarter, 38s. 6d. and 35s. 6d.; Govan, at Broomielaw, 39s. and 36s.; Shotts, at Leith, 44s. 6d. and 44s.; Carron, at Grangemouth, 48s. 6d. and 45s. 6d.; Kinneil, at Bo'ness, 43s. and 42s.; Glengarnock, at Ardrossan, 42s. 6d and 39s. 6d.; Eglinton, 38s. 9d. and 35s. 6d.; Dalmellington, 40s. 6d. and 37s. 6d.

The iron and steel manufactured goods—exclusive of pig iron—despatched from Glasgow in the past week were comparatively small in amount and in value, embracing £3050 worth of machinery, £1000 sewing machines, £3000 steel goods, and £19,000 general iron manufactures, of which £7250 represented tubes, bars, and pipes for Canada, and £5660 bars, plates, sheets, and pipes for Bombay.

The shipping department of the coal trade has been fairly active this week, and the prospects are, on the whole, satisfactory as to the amount of business likely to be done in the immediate future, although the prices continue very low, with no immediate hope of improvement. The total quantity shipped during the week has been 92,561 tons, as compared with 77,100 in the corresponding week of last year. From Glasgow 24,281 tons were despatched; Greenock, 2366; Ayr, 10,703; Irvine, 2729; Troon, 7139; Burntisland, 13,040; Leith, 5913; Grangemouth, 15,680; Bo'ness, 9450; and Port-Glasgow, 1250 tons.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

I AM rather inclined to the opinion that the lowest deep has been reached in the steel rail trade, and that from the present time an upward step will be made. Prices have fallen as low as they can fall. A manager of one of the largest works in Wales told me a day or two ago that the present price for best steel rails, heavy section, was £3 10s. No one has ever known the like. Iron was never so cheap, not even the peculiar cruder alloyed hot-blast iron, which had a tendency to snap like a carrot, to use a local illustration. Now, at £3 10s. for a really fine sample of best steel rail, with a long life attached to its service, if any business is to be done, now is the time, and I believe that colonial orders are being placed freely, or will be in the course of a week. Ironmasters can only give such quotations by the unparalleled prices of foreign ore, the low price of coke, and the labour rate. Ordinary labour was never so low; 2s. a day represents far higher than the average.

Bilbao Mine is at 10s., and to my knowledge Cyfarthfa used to pay 13s. for Welsh ore that was not a third of the value of foreign ore.

Iron and steel returns for the first four months of the year are just completed, and show that Wales has been as fairly occupied as any other district in these excessively bad times, Consett and Middlesbrough perhaps excepted. In the four months Cardiff has exported nearly 15,000 tons, Swansea 2400, and Newport 34,381 tons iron and steel.

The principal make for home has been steel bar for tin-plates, and in this four of the works are rather busily engaged. Swansea continues to be moderately occupied with steel plates, and Dowlais and Tredegar with steel sleepers. I have been glad to see a large number, too, of steel rails from Dowlais carried on the joint Rhymney and Great Western lines.

Mr. David Williams, Pontypool, has entered upon the management of the Pentyrch Works.

Mr. Rees Jones has succeeded Mr. T. H. Riches at the Ocean Collieries. Mr. Riches was in his youth connected with the press, and entered the employment of Mr. S. Thomas as junior clerk, becoming by his energy and ability partner in one of the finest collieries of Wales. Mr. Rees Jones has had great experience, and from the first has been identified with Harris's Deep Navigation, a colliery now in Mr. Price's hands doing good work.

The impression at Cardiff is that the turn in the coal trade is come. Those who have watched closely the business of the collieries and docks have seen the little improvement of three weeks ago steadily progress, and, though small, this is hopeful; and what is better, the improvement has general features, and is not localised. The ironworks collieries from Ebbw Vale to Cyfarthfa are doing better. Dowlais collieries from Bengoed to Bedlinog are worked more vigorously; Monmouthshire and Swansea collieries show the same signs, and Rhondda, from Hafod to Treherbert and the Tylerstown and Ferndale, are all sharing in the upward movement.

I hope to record this steadily week after week. It will take a long time to make up for lost ground, and some collieries may yet not survive the long and disastrous stagnation. The Gnoll Colliery, Neath, has been closed. The cause assigned is the excessive rating. One hundred men have been thrown out, thanks to the vigour of agents and others. The strike of banksmen at the Navigation Colliery has not led to a stoppage. Notices are still pending in Aberdare Valley on some minor collieries.

The tin-plate workers have scored a success in getting the Home Secretary to concede liberty for boys of certain ages to work at night in the mills. The trade may be regarded as tolerably firm; exports have been large this week, and though new orders are sparingly placed, workers are well booked.

Quotations remain about the same: Coke plates up to 14s,, cheap cokes as low as 13s. 3d., Siemens fetch as high as 14s. 6d., and charcoal go up to 17s. 6d. The export of last week was close upon 40,000 boxes, principally Baltimore and New York. Compared with April returns of last year, the increase to America of tin-plate is fully 106 per cent.

Stock of tin-plates now held in Swansea is slightly over 130,000 boxes.

Swansea coal shipments last week were dull. One significant item to Greece was iron. Another significant item of imports was pig iron from Bilbao, 110 tons, consigned to the Landore Steel Company. Probably, however, so long as labour is so cheap here, we have not much reason to fear Spanish pig iron competition.

Treherbert Foundry, now allied with the Bute Dry Dock, is doing substantial work under the spirited management of Mr. H. W. Lewis. Some of its best machinery has just been sent to Virginia, and the other day was despatched a fine inverted 20 engine, 2ft. stroke, well designed and finished, for coal washing and grinding in Cumberland. Wales is looking up.

NEW COMPANIES.

The following companies have just been registered:—

Unity Ironworks, Limited.

This is the conversion to a company of the business of millwrights, engineers, &c., carried on by Messrs. Wm. Musto and Co., at the Unity Ironworks. It was registered on the 29th ult. with a capital of £10,000, in £5 shares, with the following as first subscribers:—

	Shares.
Hiram Codd, 41, Gracechurch-street, engineer ..	40
T. E. Harper, 23, Rood-lane, solicitor	20
W. W. Macray, Castleford, Yorkshire, glass manufacturer	10
E. Frieddeberg, Lower Merton, furrier	5
H. Sparks, 71, Whitechapel-road, tobacco manufacturer	10
J. Warner, Osborn-street, Whitechapel, ironfounder	20
R. Sykes, Castleford, glass manufacturer	10

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

Universal Cool Air Drying Company, Limited.

Upon terms of an unregistered agreement of the 29th ult., this company proposes to purchase the business of cool air drying carried on by Messrs. W. H. Murray, H. Wilson Hart, and F. J. G. Hill. It was incorporated on the 5th inst. with a capital of £30,000, divided into 1000 preference shares of £10 each, and 4000 ordinary shares of £5 each. The subscribers are:—

	Pref. Shares.
*A. W. Money, Liss, Hants	10
Worsley Roberts, St. Leonards	10
Paul Ewen, C.E., 87, Shirland-gardens, Maida-vale	10
E. J. Neale, Bedford Park	1
A. D'Arcy Bannerman, 9, Woodlands-road, Barnes	1
R. Minns Norton, Nicholson-road, Addiscombe ..	1
*H. J. Nevill, 45, Charles street, Berkeley-square	1

The number of directors is not to be less than three nor more than seven; qualification, 25 shares; the first are the subscribers denoted by an asterisk and Mr. Thos. Paine Hilder, of 8, Draper's-gardens. The company in general meeting will determine the remuneration.

Berrima Coal Mining and Railway Company, Limited.

This company was registered on the 30th ult. with a capital of £75,000, in £1 shares, to acquire and work the Berrima Collieries, situate near Berrima, county of Camden, New South Wales. The subscribers are:—

	Shares.
H. C. Hollingsworth, 483, Old Kent-road	1
Norman Earto, 12, Howden-road, Lee	1
L. Southall, 29, Spurstowe-road, E., clerk	1
C. J. Otway, 140, St. Thomas-road, Finsbury Park	1
J. H. Clarke, Upton, Essex	1
B. How, 142, Strand, accountant	1
T. Charton, South Darenth, near Dartford	1

The number of directors is not to be less than three nor more than five; qualification, 100 shares; the subscribers are to act as directors until others are appointed; remuneration, £1000 per annum.

Clayton, Son, and Co., Limited.

This is the conversion to a company of the business of boiler-makers and gasholder-makers carried on by Messrs. Clayton, Son, and Co., at Moor-end, Hunslet, Leeds. It was registered on the 3rd inst. with a capital of £40,000, in £10 shares, divided as follows:—

	Shares.
*Laurence Clayton, Hunslet, Leeds, boiler-maker, &c.	2562
Mrs. E. Clayton, Hunslet, Leeds	50
*J. Hartley, Hunslet, Leeds, boiler-maker	1156
L. Hartley, Hunslet, Leeds, gasholder erector ..	50
C. Parfitt, Hunslet, Leeds, gasholder erector ..	50
*J. R. Pickering, Beeston-hill, Leeds, draughtsman	55
W. Briggs, Hunslet, Leeds, currier..	50
J. Baines, Hunslet, bookkeeper	27

The number of directors is not to be less than three nor more than seven; qualification, £500 in shares or stock; the first are the subscribers denoted by an asterisk; the company in general meeting will determine remuneration.

Fusee Vesta Company, Limited.

On the 5th inst. this company was registered with a capital of £15,000, in £5 shares, to carry on the manufacture of matches, and for such purpose to adopt an agreement of the 3rd inst. (unregistered) between Richard Bell and F. A. Lillicrap. The subscribers are:—

	Shares.
A. H. Miller, 8 and 10, Moorgate-street, solicitor	1
J. Strotton, Apsley Villa, Twickenham	1
G. A. J. Comell, 10A, Great Queen-street, Westminster	1
W. Doherty, 6, Great Newport-street, W.C., printer	1
W. R. Moore, Caxton-road, Wood-green, financial agent	1
R. Bell, 24, St. John's-hill-grove, New Wandsworth, vesta manufacturer	1
W. R. Harford, Vine Lodge, Surbiton, commission agent	1

Registered without special articles.

Hydrogen-Amalgam Company, Limited.

This company proposes to acquire mineral, chemical, and electrical properties and inventions, and in particular will purchase certain patents and other rights referred to in an unregistered agreement of the 22nd ult. between B. C. Molloy, M.P., of the first and second parts, and J. R. Yates, of the third part. It was incorporated on the 4th inst. with a capital of £200,000, in £1 shares. The subscribers are:—

	Shares.
*John Grove Johnson, 23, Cross-street, Finsbury, assayer to the Bank of England	1
*B. C. Molloy, M.P., 3, Elm-court, Temple, barrister	1
*F. W. Browne, 30, Wood-street, refiner	1
G. Colladon, Cromwell House, Twickenham, merchant	1
H. W. Spratt, 43, Queen Victoria-street, architect	1
A. Brogden, J.P., 9, Victoria-chambers	1
T. Wakefield Binyon, Croydon, solicitor	1
J. C. de Castro, M.D., Torquay	1

The number of directors is not to be less than three nor more than seven; qualification, 200 shares; the first are the subscribers denoted by an asterisk; the company in general meeting will determine remuneration.

Morewood and Co., Limited.

This company proposes to purchase the business of Morewood and Co., iron and brass manufacturers, upon terms of an agreement of the 4th inst. It was incorporated on the 5th inst. with a capital of £250,000, in 2500 shares of £100 each, whereof 478 shares are 5 per cent. preference shares. The subscribers are:—

	Shares.
H. G. Heathfield, 72, Beaufort-road, Edgbaston, Birmingham, manager	1
*R. Heathfield, Redditch, manufacturer	1
*M. Hetherington, Kenilworth, manufacturer ..	1
*J. Hetherington, Kenilworth, manufacturer ..	1
*A. Johnston, Woodford-green, Essex, manufacturer	1
G. Lindisay, Bethune-road, Stamford-hill, London manager to Morewood and Co.	1
C. Wilson, 15, Greenfield-crescent, Edgbaston, engineering student	1

The number of directors is not to be less than three nor more than seven; the first are the subscribers denoted by an asterisk.

Dewars and Bournes, Limited.

This is an amalgamation and conversion to a new company of the business of linen, silk, woollen, and general Manchester warehousemen, manufacturers, and merchants, carried on by Messrs. D. Dewar, Son, and Sons, Limited, at 12, Wood-street, and 3, Clement's-lane, Wood-street, E.C., and the business of silk, lace, ribbon, trimming, button, braid, and general Manchester warehousemen, carried on at 10, Wood-street, by Messrs. C. W. Bourne and Co. It was registered on the 29th ult. with a capital of £150,150, divided into 14,300 shares of £10 10s. each. The subscribers are:—

	Shares.
*J. W. Colmer, 12, Wood-street, merchant	1
*J. E. C. Mathews, 12, Wood-street, merchant ..	1
H. H. Bothamley, 13, Queen-street	1
*C. W. Bourne, 10, Wood-street, merchant	1
*W. C. Maughan, 10, Wood-street, merchant	1
*F. Crockford, 67 and 68, King William-street, merchant	1
A. Clark, 12, Wood-street, secretary	1

The number of directors is not to be less than three nor more than seven; qualification, 100 shares; the first are the subscribers denoted by an asterisk. The company in general meeting will determine remuneration.

THE PHYSICAL SOCIETY.

At the meeting of this Society on May 8th, 1886, Professor H. McLeod, F.R.S., Vice-President, in the chair, Mr. W. A. Price was elected a member of the Society. The following communications were read:—"On a Modified Form of Wheatstone's Rheostat," by Mr. Shelford Bidwell. A wire is coiled upon a non-conducting cylinder as in the ordinary forms of rheostat, one end of the wire being in contact with the brass axle of the cylinder. A screw is cut upon the axle, the pitch being equal to the distance between the consecutive turns of the wire, and this, working in a fixed nut, causes the whole cylinder to travel in the direction of its axis. A fixed spring bears upon the wire at a convenient point, and by the travelling motion of the cylinder this point of contact remains fixed in space, and the effect of turning the cylinder is to introduce more or less resistance between the spring and the brass axle. Binding screws on the base of the instrument are in contact with the nut and the bearing spring. Though this arrangement has several obvious advantages over the usual forms, Mr. Bidwell does not recommend it in cases where it is required to introduce a known resistance, but where it is important to adjust a resistance to a nicety or to cause a continuous variation it is of great use. Professor Perry, remarking upon the importance of being able to vary a resistance gradually, described an instrument he had used with advantage. A number of plates of gas carbon are placed between two parallel copper plates, one of which is fixed, and the other adjustable by a screw; by applying pressure by means of the screw the resistance between the plates can be varied uniformly and regularly from 2 to 10 ohms, beyond which point the increase is very rapid. "On a Theorem Relating to Curved Diffraction Gratings," by Mr. Walter Baily. In a paper read before the Society in January, 1883, the author showed that if a plane be taken perpendicular to the lines of a curved diffraction grating and a normal to the grating be taken as the initial line, then the equation

$$\frac{\text{Cos.}^2\,\theta}{r} = \frac{\text{cos.}\,\theta}{c} + \frac{1}{d},$$

in which c is the radius of curvature of the grating, and d is an arbitrary constant, gives a curve having the property that if a point of light be placed anywhere upon it, the curve is the locus of the foci of all diffracted rays whether reflected or transmitted. In the present investigation d is supposed to be greater than c, which allows of the source of light being at infinity. The points where the curve given by the above equation cuts the normal are called the normal foci. There are two of these—one relating to the reflected and the other to the transmitted light—the grating being supposed to consist of a number of opaque lines in space. It is then shown that if the grating be supposed to turn about the line in it intersecting the initial line, the normal foci will trace out two parabolas whose common focus is the origin, and common latus rectum is equal to the diameter of curvature of the grating, the parabola for reflected light being convex to the source of light, and that for transmitted light, concave. "On Some Thermodynamical Relations," Part IV., by Professor W. Ramsay and Dr. Sydney Young. The first part of this communication deals with Professors Ayrton's and Perry's criticisms upon the previous papers by the authors upon this subject. In the second part a brief review is given of the various attempts that have been made to represent the pressure of a saturated vapour as a function of the temperature.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Applications for Letters Patent.

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

4th May, 1886.

6005. Opening and Closing the Doors of Hansom Cabs, G. Wall, London, and W. A. W. Orr, Didsbury.
6006. Punching Machines for Cards used on Jacquards, &c., E. Roe and G. Kent, Calais.
6007. Fastening for Doors for Fireproof Buildings, T. Harby, Manchester.
6008. Button Fasteners, A. Gray, Birmingham.
6009. Cartridge Chargers for Machine Guns, L. F. Bruce, Paris.
6010. Fastenings for Corsets, A. J. Heys, Manchester.
6011. Firelighter, W. H. Phillips and J. R. Campbell, Belfast.
6012. Adjusting Fanlights or Casements, H. T. Owens, Birmingham.
6013. Photographic Cameras, V. C. Driffield, Widnes.
6014. Throwing Objects from Traps for Shooting Practice, J. Grimshaw, Manchester.
6015. Igniting Matches, W. Brampton, Birmingham.
6016. Coupling Railway Vehicles, G. Chaplin, Birmingham.
6017. Rings for Top Notches and Runners of Umbrellas, S. W. Hallam, Sheffield.
6018. Coupling Railway Carriages, S. Skerritt, Sheffield.
6019. Gas Brackets, R. H. Best, Handsworth.
6020. Gas Chandeliers or Pendants, R. H. Best, Handsworth.
6021. Windows of Cabs, Tram-cars, &c., W. H. Bodin, Birmingham.
6022. Air or Gas Compressors, G. E. Dow, London.
6023. Portable Tents and Awnings, E. J. Passingham, Bradford.
6024. Receptacles for Human Excreta, W. H. Bowers, London.
6025. Removing Excreta from Receptacles, W. H. Bowers, London.
6026. Making Hollow Articles of Paper Pulp, &c., B. Heinert, London.
6027. Reproducing Sounds, J. Y. Johnson.—(*The Volta Graphophone Company, United States.*)
6028. Waterproof Cloak, I. Manschester, London.
6029. Dust-pan, S. Guinery, Epsom.
6030. Driving Bands, J. Lee, Halifax.
6031. Cleaning the Wheels of Perambulators, &c., O. E. Heiing, London.
6032. Lamps, J. H. Walker, London.
6033. Lock and Catch, R. G. Owen, London.
6034. Oil Feeders, A. J. Boult.—(*J. E. Blakemore and S. A. Randall, United States.*)
6035. Telephonic Receivers, A. J. Boult.—(*W. Marshall, United States.*)
6036. Continuous Nail Wire, T. Fowler and T. B. de Forest, London.
6037. Dies for Making Nail Wire, T. Fowler and T. B. de Forest, London.
6038. Button Fastener Machines, A. J. Boult.—(*F. H. Richards, United States.*)
6039. Taps for Cutting Screw Threads, A. J. Boult.—(*W. Murchey, Canada.*)
6040. Scholars' Companion, T. Webb.—(*T. D. Richardson, United States.*)
6041. Preparing Leather and Skins, F. R. Maggs, Yeovil.
6042. Reproducing Sounds, J. Y. Johnson.—(*The Volta Graphophone Company, United States.*)
6043. Wearing Apparel, R. Haddan.—(*R. Hicks, United States.*)
6044. Magneto-phones, F. H. Brown, London.
6045. Treating Whale Finners, H. Harvey and T. Richardson, London.
6046. Preventing the Displacement of Keys used in Securing Railway Rails to Chairs, &c., G. Wells, London.
6047. Reproduction of Speech, &c., J. Y. Johnson.—(*The Volta Ghaphophone Company, United States.*)
6048. Receptacle for Soap, &c., E. Bond, London.
6049. Repeating Fire-arms, C. Honor.—(*J. S. V. Burbery, Ceylon.*)
6050. Furnaces for Steam Boilers, &c., T. Lishman, London.
6051. Marine Boiler Furnaces, &c., J. R. Fothergill, London.
6052. Shuttles for Looms, E. G. Brewer.—(*W. Pohlig, Germany.*)
6053. Fire-lighters, W. Abbott, London.
6054. Duplex Action Runner for Umbrella, G. B. Matthews, London.
6055. Support for Flowers, J. Pope, London.
6056. Motor Engines, J. F. Schnell, Manchester.
6057. Speed Gear, G. G. Tandy, C. M. Linley, and J. Biggs, London.
6058. Door Closers, W. Potter and R. W. Papineau, London.
6059. Using Liquid Fuel for Locomotives, J. Holden, London.
6060. Machine for Dressing Castings, &c., J. Mackie, Reading.
6061. Roofing Tiles, L. A. Groth.—(*F. L. Perrière, France.*)
6062. Transmitting Sounds, J. Y. Johnson.—(*The Volta Graphophone Company, United States.*)
6063. Extending Power of Horse Draught, R. Adams, Glasgow.
6064. Teaching Needlework, E. A. and A. F. Lambert, London.
6065. Washing Ores, A. R. Gray, Edinburgh.
6066. Preserving Iron, &c., J. H. Johnson.—(*A. de Meritens, France.*)
6067. Filtering Sewage, G. D. Robertson.—(*B. James, United States.*)
6068. Shirts, E. J. Forbes, London.
6069. Making Compressed Yeast, S. A. W. Howmann, London.
6070. Mordants, H. H. Lake.—(*C. N. Waite, United States.*)
6071. Steam Valves, W. H. Empsall, London.
6072. Purifying Water, P. A. Maignen, London.
6073. Manuals for Musical Instruments, A. Montgomery, London.
6074. Operating Signals, J. Coleman and I. Henson, Derby.
6075. Galvanic Batteries, A. Heguilus, France.

5th May, 1886.

6076. Sheet Flyers for Printing Machines, W. Crompton, Warrington.
6077. Creating, &c., Air Draught in Boilers, A. MacLaine, Belfast.
6078. Spinning Machinery, T. F. Wallwork, Manchester.
6079. Spinning, &c., Fibrous Substances, T. Ashworth, Manchester.
6080. Cutting Angled Pillars, &c., W. Greenwood, Halifax.
6081. Springs for Velocipedes, J. R. Trigwell, London.
6082. Building Concrete Walls, T. Potter, Alresford.
6083. Prop for Supporting Lids of Desks, T. Monteath, Crieff.
6084. Cutting Indices in Books, P. Lawrence and C. P. Shrewsbury, London.
6085. Bottles, J. M. Day, Dublin.
6086. Draught-preventing Appliances, J. M. Martin, Liverpool.
6087. Ships' Berths, D. Macallan, Liverpool.
6088. "Tailormetre," C. J. Cleaver, Warwickshire.
6089. Emery Paper, &c., D. Crossley, Yorkshire.
6090. Automatic Doors, J. J. Arnold, Southampton.
6091. Preventing Shocks in Pipes, C. von Sluyterman, London.
6092. Cricket Bats, &c., W. Sykes, Yorkshire.
6093. Stirrup, W. J. Smith, Barnsley.
6094. Screw Fans, C. S. de Bay, London.
6095. Protecting Points of Pencils, &c., F. Wolff, Manchester.
6096. Van, A. Butler, Bradford.
6097. Roller Blinds, E. Kerry and E. C. Kerry, Highgate.
6098. Water Fittings, &c., J. McMurtrie, Glasgow.
6099. Valve Apparatus, R. Mason, jun., Glasgow.
6100. Water-closets, W. Macfarlane, London.
6101. Removing Sediment from Steam Boilers, F. Robson and R. Ord, London.
6102. Electrical Switching Apparatus, W. T. Goolden and A. P. Trotter, London.
6103. Hinges, E. Flint and W. Knowles, London.
6104. Cut-off or Expansion Gear of Engines, J. H. Street, London.
6105. Toothache Specific, W. C. Wilmore, London.
6106. Tire for Wheels, C. D. Abel.—(*The Actien Gesellschaft, "Prinz Leopold," Germany.*)
6107. Telegraphic Transmitter, A. Browne.—(*D. Piedrahita, Colombia.*)
6108. Lowering the Temperature in Buildings, &c., A. Doig, London.
6109. Governors for Motive Power Engines, &c., A. Shaw, London.
6110. Advertising, A. Lafargue, London.
6111. Steam Generators, G. F. Redfern.—(*F. C. Garbutt, United States.*)
6112. Drying or Desiccating Germinating Barley, &c., G. F. Redfern.—(*P. Lauth, France.*)
6113. Labels and Name Plates, J. Pinches, London.
6114 Chromic Acid Batteries, D. G. Fitz-Gerald, London.
6115. Stoppering Bottles, &c., C. Dollmann, London.
6116. Dyeing Yarns, A. M. Clark.—(*J. Hanson, United States.*)
6117. Propelling Machinery, H. Fabian, London.
6118. Stopping Ships, S. French.—(*W. Haddan, United States.*)

6th May, 1886.

6119. Driving Gear of Velocipedes, C. S. Snell, London.
6120. Insecticides, W. G. Little, Conisbrough.
6121. Brick-making Machinery, J. A. and W. J. Matthews, Halifax.
6122. Holders for Umbrellas, &c., J. Everard, Birmingham.
6123. Machinery for Finishing Velvets, R. Dutton Salford.
6124. Drain Traps, G. F. Firth, London.
6125. Rein Holders, G. J. Harcourt and E. Shaw, Bristol.
6126. Incubators, H. J. H. King, Newmarket.
6127. Sole-ranging Knife, H. J. Bunting, J. J. Cotchin, J. K. Vernon, and R. Whitton, Northampton.
6128. Blast Furnaces, G. Craig, Glasgow.
6129. Signal Whistles on Tramcars, W. Walker and J. Clyne, Aberdeen.
6130. Letting-off Motion in Looms, L. Clement and N. Cork, Halifax.
6131. Lift Dobbies for Looms, B. Bridge and J. A. Calvert, London.
6132. India-rubber and Composition Mats, J. Brown, London.
6133. Hand Ironing Machine, J. Ritchie, Glasgow.
6134. Gas Regulators, R. Hargreaves and J. Bardsley, Manchester.
6135. Spindle Mountings for Spinning Machinery, J. M. Hetherington, Manchester.
6136. Eyeletting Machines, J. Carter, Manchester.
6137. Bicycles, R. Mainwaring, Southport.
6138. Firing Apparatus for Torpedoes, J. T. Bucknill and W. O. Smith, London.
6139. Adjustable Electric Switches, H. Hart, Glasgow.
6140. Telescope Cartridges for Muzzle-loading Guns, F. Simpson, London.
6141. Water-closets, P. W. Barker, Bedford.
6142. Holding Carriage Windows, J. Schöpfer, London.
6143. Vent Tap, W. G. Deacle and G Wood, London.
6144. Manufacture of Fire Clay Tuyeres, R. Young and R. Jex-Long, Glasgow.
6145. Preparation of Aluminium by Electrolysis, A. C. Henderson.—(*L. T. Heroult, France.*)
6146. Velocipedes, J. Keen, W. McWilliam, T. Humber, and T. H. Lambert, London.
6147. Pole Snap Hook, C. A. Worth, London.
6148. Snap-hooks, C. A. Worth, London.
6149. Gas Meter Cases of Sheet Metal, V. Hughes, London.
6150. Fire Polishing Glass Ware, J. G. Sowerby, London.
6151. Table or Stand for Bedsteads, A. L. Bayley, London.
6152. Self-acting Fastener for Double Doors, H. W. Hennes, London.
6153. Casing Bricks, &c., W. Whieldon and E. W. Hughes, London.
6154. Magic Lanterns and Lime-light Apparatus, D. W. Noakes, Greenwich.
6155. Lavatories, J. G. Stidder, London.
6156. Couplings, F. Broughton and G. H. Hall, London.
6157. Steam Engines, W. Schmidt, London.
6158. Tobacco Pipes, S. Reeve, C. E. Ratcliffe, and J. Brackenbury-Davis, London.
6159. Hurdles, T. Cooper, London.
6160. Spades, Shovels, &c., H. H. Lake.—(*H. M. Myers, United States.*)
6161. Gas Motor, G. F. Redfern.—(*C. F. L. Gardie, France.*)
6162. Velocipedes, E. Burstow, London.
6163. Leaving and Entering Submarine Boats or Vessels, A. Campbell, London.
6164. Dies, R. Elsdon, London.
6165. Petroleum and Gas Engines, H. H. Leigh.—(*J. Spiel, Germany.*)
6166. Stoves, A. J. Le Blanc, London.
6167. Filaments for Electric Lamps, O. R. Swete and W. C. Main, London.
6168. Land Torpedoes, M. T. Sale, London.
6169. Transmitting Motion to the Shafts of Knitting and other Machinery, H. M. Foulds, London.
6170. Soap, W. Green, London.
6171. Surface Condensers for Traction Engines, W. Wilkinson, London.

7th, May, 1886.

6172. Lubricants, F. P. Warren, Hampshire.
6173. Sleeper, J. W. Dorman, Cork.
6174. Attachment to Cabs, &c., S. H. Sparkes, Wellington.
6175. Lubricators, T. Hill, Glasgow.
6176. Flushing Cisterns, J. Deeley, Birmingham.
6177. Carts, J. B. Moorhouse and S. Hey, Skipton-in-Craven.
6178. New Game, E. Flemons, Northampton.
6179. Safety-valves, A. Turnbull, Glasgow.
6180. Advertising, J. Blakey, Halifax.
6181. Pipes, C. Lee, London.
6182. Sash Windows, R. Little, Kirkcaldy.
6183. Trap for Catching Mice, &c., S. Morley, Horsforth.
6184. Handles for Cutlery, W. T. Brooke, Sheffield.
6185. Controlling Reins in Driving, W. C. Roberts, London.
6186. Secretaires, &c., B. M. Brew and W. A. Bonella, London.
6187. Horseshoes, F. A. Roe, London.
6188. Cigarettes, F. D. Butler, London.
6189. Reflector, G. Kast. London.
6190. Preparing of M-methoxy-p-nitrobenzaldehyd, L. Landsberg, London.
6191. Bromine Preparations, W. D. Borland, London.
9192. Securing Wedges in Railway Chairs, T. Spir, Sheffield.
6193. Cleaning Ring Spinning Frames, F. W. Whipp, London.
6194. Pianofortes, E. Outram, Halifax.
6195. Shuttles, E. Haworth, Halifax.
6196. Chimney Cowls, J. B. Fryer, Buckhurst Hill

6197. Wiring Corks, N. B. Abbott, Brooklyn.
6198. Guns, G. W. Winn, Middlesex.
6199. Steam Pumps, J. Brunt, London.
6200. Burglar Alarm, C. Vincent and Thomas Downing, London.
6201. Magneto Machines, T. Bennett, London.
6202. Fasteners, H. J. Haddan.—(*J. F. A. Laloy, France.*)
6203. Carbon Filaments, H. J. Haddan.—(*C. Seel, Germany.*)
6204. Carding Engines, T. Knowles, Manchester.
6205. Elastic Fabrics, L. Turner and A. Turner, London.
6206. Electric Alarm, J. Rice, London.
6207. Picture Frame, W. J. Baker.—(*A. Werkmeister, Germany.*)
6208. Making Twist Drills, &c., A. B. Perkins and F. Butterfield, Bradford.
6209. Striking Staple, R. H. Wilson, London.
6210. Separation of Fats, H. W. Langbeck, and R. E. Ritsert, London.
6211. Bedstead, E. V. J. Coppen and J. O'Sullivan, London.
6212. Blocks for Building, E. Edwards.—(*C. Hubert and H. Gennari, France.*)
6213. Pressing Machinery, E. Edwards.—(*A. Huguet, France.*)
6214. Playing Cards, H. H. Lake.—(*G. M. Endicott, United States.*)
6215. Aerotherapeutical Apparatus, C. Breuillard, London.
6216. Fire-extinguishing Apparatus, H. H. Lake.—(*W. Harkness, United States.*)
6217. Blasting and Getting Coal, &c., H. Johnson, London.
6218. Wash Mills, W. Joy, London.
6219. Fancy Pattern Cloths, R. H. Lendrum, D. Dytch, and E. Lloyd, London.
6220. Electrical Resistance Switches, M. H. Smith, London.
6221. Fire-proof Floors, C. S. Williams, London.
6222. Explosive Cartridges for Blasting, J. Macnab, London.
6223. Pianofortes, A. M. Clark.—(*E. V. Wagner, Portugal.*)

8th May, 1886.

6224. Lightning Arresters, P. Gannon, London.
6225. Fastener for Boot Laces, C. H. M. Wharton, Manchester.
6226. Locks or Fastenings for Railway Carriage and other Doors, J. Wroe, Manchester.
6227. Pistons for Steam Engines, W. Dixon and S. Thompson, Sheffield.
6228. Hanging Up Damp Paper, &c., B. Meinert, London.
6229. Knife-cleaning Machines, J. Crabbe, London.
6230. Engines, &c., of Steam Ships to Supply Fresh Water, C. Jones, Liverpool.
6231. Braiding, &c., Machines, S. Robinson and J. Hartley, Manchester.
6232. Penman's Friend, W. Peck, Woodlesford.
6233. Electrical Phenomenon Apparatus, A. Philburn, Ashton-under-Lyne.
6234. Cutlery, W. H. Blackwell, Manchester.
6235. Reversible Electric Machine, J. Enright, London.
6236. Traps for Catching Animals Alive, E. T. Nicholson, Abergele.
6237. Embroidering Machines, E. Cornelly, London.
6238. Picture Framing and Mitreing, W. Pringle, Berwick-upon-Tweed.—*May 6th.*
6239. Stoves, A. M. Clark, London.
6240. Watering, &c., Dust in Coal, &c., Mines, G. Hutchins, Cardiff.
6241. Prevention of Collisions at Sea, &c., F. McNamee, Wexford.
6242. Coupling for Railway Vehicles, R. C. Sayer, Newport.
6243. Perambulators, &c., C. R. Gorman and C. J. Fletcher, Birmingham.
6244. Additional Movement to Horses of a Round-about, R. Tidman, sen., R. Tidman, jun., and F. Tidman, Norwich.
6245. Electric Machines, C. Wells, London.
6246. Incandescent Lamp, C. Wells, London.
6247. Incandescent Lamps for Illuminations, &c., C. Wells, London.
6248. Plough, S. S. Bromhead.—(*F. Perrier, France.*)
6249. Bung Bushes and Bungs, W. Kromer, London.
6250. Tension Apparatus for Spinning Machinery, J. C. Mewburn.—(*E. Prévost, France.*)
6251. Casting Iron and Steel Ingots, W. D. Allen, London.
6252. Weaving Elastic Fabrics, L. Turner, London.
6253. Furnaces for Manufacturing Illuminating, &c., Gas, P. M. Justice, London.
6254. Hammock Chairs, G. B. Hook, London.
6255. Checking, &c., Distances in Tramcars, &c., H. Woolfe, Liverpool.
6256. Combination Tables, &c., J. P. Farrell, London.
6257. Registering Distance Travelled in Cabs, &c., J. Clifford, West Barnes.
6258. Explosive Compound for Blasting Purposes, C. D. Abel.—(*F. Gaens, Germany.*)
6259. Extraction of Perfume Essences, C. D. Abel.—(*La Société Anonyme des Parfums naturels de Cannes, France.*)
6260. Fire-lighter, J. H. Webster and J. Silson, London.
6261. Hats, &c., T. Townend and A. Powell, London.
6262. Iron and Steel Tubes, F. Huggins, London.
6263. Cases for Flowers, W. Cutler, London.
6264. Pressing Woollen Fabrics, G. H. Nussey and W. B. Leachman, London.
6265. Gloves, E. Horsepool, London.
6266. Labour Appliances for Women, E. Diver, Kenley.
6267. Removing Thistles, &c., from Wool, W. H. Beck.—(*A. Broux, fils, France.*)
6268. Rock-drilling Machines, H. H. Lake.—(*S. Hussey, United States.*)
6269. Stop-cock, J. A. Hopkinson and J. Hopkinson, London.
6270. Handles for Table Knives, &c., H. H. Lake.—(*R. N. Oakman, jun., United States.*)
6271. Feed-water Heaters, H. H. Lake.—(*H. Fairbanks, United States.*)
6272. Axle-boxes, H. K. Austin, London.
6273. Facilitating Rock Boring Under Water, V. N. Goldsmith.—(*W. R. Sanders, Sicily.*)
6274. Ore Concentrators, J. N. Longden, London.
6275. Fog Horn, E. Martin, London.
6276. Folding and Boxing Braids, &c., A. Butler, Bradford.
6277. Buckles, J. Adams, York.
6278. Automatically Regulating Fuel Supply, &c., J. Barnes, J. Sutcliffe, and R. Percival, Hopwood Heywood.
6279. Horse Gears or Works, A. W. Harrison, Abergavenny.
6280. Frame for Packing Seal Skins, &c., H. Lister, Huddersfield.
6281. Jewel and Flower Pins for Neckties, W. Brierley.—(*C. Hüffner, Germany.*)
6282. Absorbing Gases by Liquids, F. N. Mackay, Liverpool.
6283. Destroying Refuse, F. Kingdon and G. Wilde, Bradford.
6284. Soaking Mould for Steel Ingots, T. and A. Doughty, Glasgow.
6285. Metallic Handles for Pocket Knives, &c., C. Ibbotson, Sheffield.
6286. Hydraulic Pressure Hot-air Generator, J. Tennent, Grangemouth.
6287. Electric Secondary or Storage Batteries, W. Taylor, London.
6288. Binding Sheets of Paper, &c., G. F. Whittle, London.
6289. Folding Focussing Camera Screen, A. J. Jamouneau, London.
6290. Dress Preservers, A. C. Henderson.—(*P. P. Guillaume, fils aîné, France.*)
6291. Twist Drills and Holders, F. Butterfield, Liverpool.
6292. Oscillating Chimney Top, G. Sharp, sen., St. Leonards-on-Sea.
6293. Stirrup Iron, C. I. C. Bailey, London.
6294. Horse Collar, C. I. C. Bailey, London.
6295. Apparatus for Advertising, T. M. Potter and T. Allen, London.
6296. Bicycle, &c., Cranks and Levers, W. Owens, London.
6297. Needle Case, &c., F. W. Amsden, London.
6298. Hangers for Wearing Apparel, A. M. Kennard, London.
6299. Extinguishing Fires, F. Bolton, London.
6300. Smelting and Refining Gold, &c., J. M. Bennett, Glasgow.
6301. Permanent Way of Railways, W. G. Davidson, Glasgow.
6302. Garment Holders, H. J. Haddan.—(*H. Christian, Austria.*)
6303. Electrical Indicators, B. J. B. Mills.—(*J. W. Howell, United States.*)
6304. Cardboard or Paper Boxes, L. W. Stone and L. Gunn, London.
6305. Projectiles for Ordnance, J. Vavasseur, London.
6306. Drying Waste Animal Matter, J. S. and J. Edwards, London.
6307. Portable Tool for Gamekeepers, W. P. Birch, London.
6308. Heating Food, E. C. Costa, London.
6309. Lavatory Basins, Water-closets, &c., J. W. Reid, London.

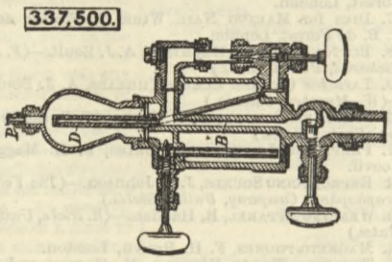
SELECTED AMERICAN PATENTS.

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

337,500. Lubricator, *Leopold Kaczander, New York, and Robert Ruddy, Mount Vernon.—Filed January 12th, 1886.*

Claim.—(1) The combination, with the oil and condensing chambers of a lubricator, of two steam jets or pipes connected with a source of continuous steam supply and discharging into the condensing chamber from opposite directions, one of said jets or pipes communicating with the oil-discharge passage, substantially as and for the purposes hereinbefore set forth. (2) The combination, with the oil and condensing chambers and their connections and the top steam pipe p, of the steam channel B and the central steam pipe D extending up into the condensing chamber and closed at top, and provided with lateral discharge holes h, as and for the purposes hereinbefore set forth. (3) The combination, with the oil and condensing chambers, the sight-feed, and the oil and water-regulating devices, of two steam jets, communicating with a source of continuous steam supply and discharging into the condenser, supplying the condenser, entering the one centrally and vertically from the top and the other centrally and vertically from the bottom of the condensing chamber, the two being arranged so that

337,500.

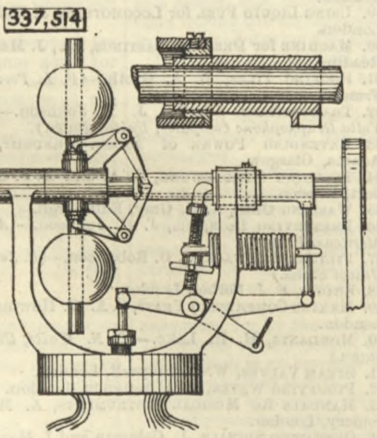


they shall meet near the top of the condenser, substantially as and for the purposes hereinbefore set forth. (4) The combination, with the oil and condensing chambers, of the central steam pipe D, with closed top and lateral openings h, and the opposed steam pipe p, substantially as and for the purposes hereinbefore set forth. (5) The combination of the oil chamber, the condenser chamber, the sight-feed and their connections, the conduit passage up through the oil chamber, and discharging into the condenser chamber, and having a branch leading to the sight-feed glass, whereby said conduit serves at once for the supply of steam and the discharge of oil, a branch pipe from said conduit to a source of continuous steam supply, and an auxiliary pipe p leading into the condenser from the same source of steam supply, these parts being arranged and organised as and for the purposes hereinbefore set forth.

337,514. Governor, *William M. Norcross, Brooklyn, N.Y.—Filed August 6th, 1885.*

Brief.—In the event of the breaking of the belt the shaft A will spring upward so that the shoulder y^1 will

337,514

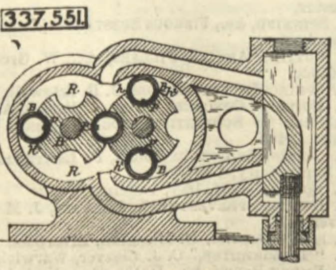


clear the projection q^1 q^{11} and allow the tube y to slide in the collar q, thereby relaxing the tension of the spring o and allow the valve to close.

337,551. Rotary Engine, *William Berrenberg and Adolph Berrenberg, Boston, Mass.—Filed July 13th, 1885.*

Claim.—(1) The combination, with rotating intermeshing pistons or cams of otherwise ordinary or suitable construction and arrangement, of teeth B,

337,551

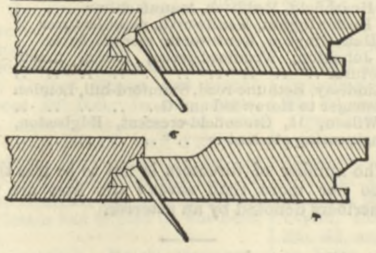


separately made, and each of a tube fitted within a seat F, of, and attached to the piston, substantially as described, for the purpose specified. (2) The combination, with rotating intermeshing pistons or cams of otherwise ordinary or suitable construction and arrangement, of teeth B, constructed substantially as shown for the admission of steam thereto, and thereby to be expanded, substantially as described, for the purpose specified. (3) The combination, with rotating intermeshing pistons or cams of otherwise ordinary or suitable construction and arrangement of teeth B, made in expansible layers $a'b\,d$, separated by spaces fg, each closed to each other but having a separate port $h\,h^2$, making communication with the chamber R of the piston casing H, substantially as described, for the purpose specified.

337,564. Siding for Buildings, *Albert C. Daugherty, North Belle, Vernon, Pa.—Filed November 14th, 1885.*

Claim.—Siding for buildings, consisting of the boards being of uniform thickness throughout, the outer sides of the tongued edges thereof cut away beneath the extended outer lips of the grooved edges

337,564.

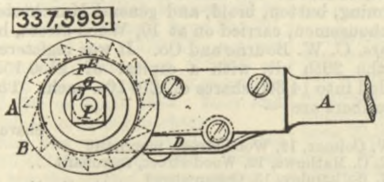


to form a watershed to each course, in combination with the inclined surfaces on the tongued edges, through which the nails are driven, substantially as and for the purpose herein described.

337,599. Ratchet-drill, *Jules Magnette, Long Island City, N.Y.—Filed November 25th, 1885.*

Claim.—In a ratchet-drill, the combination, with the screw socket E, of the ratchet wheel B, and the feed-screw H, having point I and polygonal head J, of the

337,599.

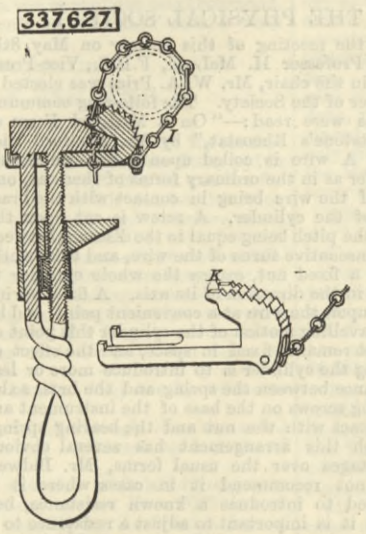


intermediate telescoping screws, F G, and their stop pins L, substantially as herein shown and described, whereby the feed-screws can be extended or contracted as may be required.

337,627. Pipe Wrench Attachment for Monkey Wrenches, *F. H. Seymour, Detroit, Mich.—Filed November 14th, 1885.*

Claim.—(1) In combination with a monkey wrench, a pipe attachment consisting of a slotted shank adapted to straddle the post or posts of the wrench and having at its end upturned lugs, and a cam-shaped head having a chain fastened to one end thereof, and at the other end a slot to receive the free end of said

337,627.

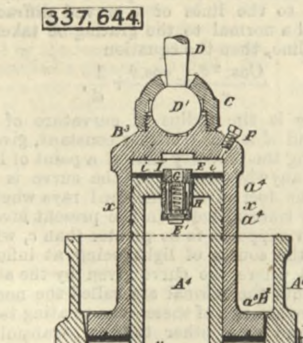


chain, substantially as shown and described. (2) As a new article of manufacture, a pipe wrench attachment consisting of a slotted shank adapted to straddle the post of a wrench, and provided with a toothed cam head having lugs K K, and a chain I, attached to said cam head, substantially as described.

337,644. Dash-pot for Steam Engines, *J. Young, Newark, N.J.—Filed December 21st, 1885.*

Claim.—(1) The post A^4 made hollow, as shown, in combination with the valve G, mounted in the interior near the top, a spring H, and piston B, adapted to form a tight vacuum chamber over the post, and an annular cushioning chamber or dash-pot around the bottom, as herein specified. (2) The post A^4, piston B, and cylinder A^5 A^6, tapered below the offset, and arranged for joint operation as herein specified. (3)

337,644

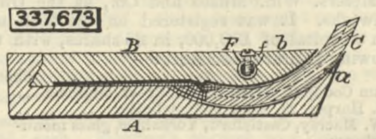


The piston B, cap C, and rod D, with its spherical end D^1, in combination with each other and with the post A^4, valve G, and cylinder A^5, arranged for joint operation as herein specified. (4) In a dash-pot, the bottom chamber z, and passage m between the same and the cushioning chamber y, in combination with the piston B and operating means D, arranged to serve as herein specified. (5) The duplicate passages $m\,n$ and controlling means M N, leading from different levels in the dash-pot, communicating with the same bottom chamber, and arranged to serve as herein specified. (6) In a dash-pot, in combination with the rim A^5, piston B, operating means D, hollow post A^4, valve G, and spring H, the removable casing E, adapted to serve a herein specified.

337,673. Lathe Tool, *Carl A. Ekland and John F. Westin, Worcester, Mass.—Filed November 27th, 1885.*

Claim.—(1) The within-described tool, composed of the bar A, having the longitudinal cavity and curved seat a internally thereof, the piece B, having the curved bearing b, fitted within the cavity of said bar, and the curved cutter C, formed as shown, and sup-

337,673

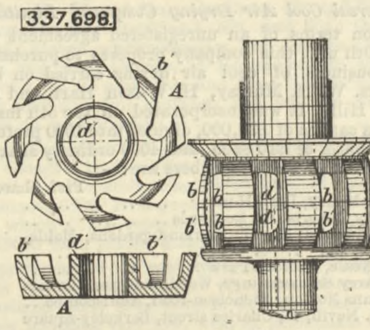


ported and held between said seat and bearing substantially as set forth. (2) The combination, with the bar A, the top piece B, and cutter C, of the stud F and screw f, substantially as and for the purpose set forth.

337,698. Rotary Cutters, *Oscar L. Noble, Boston, Mass.—Filed January 2nd, 1886.*

Claim.—The rotary cutter above described, consisting of discs A A^1, having teeth b b^1, projecting

337,698.

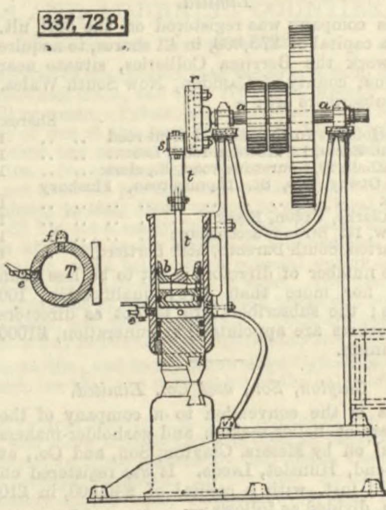


inwardly, and a separating sleeve d d^1, said discs adapted to be secured to a shaft and simultaneously rotated, substantially as and for the purpose set forth.

337,728. Pneumatic Hammer, *Carl Arnold Arns, Remscheid, Prussia, Germany.—Filed October 23rd, 1884.*

Claim.—In combination, the shaft a, face plate r, adjustable crank pin s, pitman t, piston b, cylinder T,

337,728.

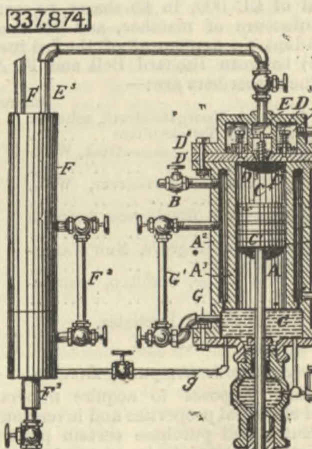


hammer D, the cylinder having space between piston and hammer, and the valve e and check valve f, opening from said space, as set forth.

337,874. Refrigerating Machine, *Jacob Schuhle, San Antonio, Tex.—Filed March 2nd, 1885.*

Claim.—(1) In an ice machine, a pump cylinder A, an oil chamber C in the lower end thereof, a jacket A^2, forming a gas chamber surrounding said cylinder and provided with openings a at the bottom thereof, in combination with a valve-supporting plate D′ and cap piece D^2, attached to the upper flange of the jacket A^2, substantially as and for the purpose described. (2) In an ice machine, a valve-supporting plate D′, provided with a series of supply valves D^3, arranged in a circle around a discharging valve D^4, in combination with a cap or cover D^2, forming a supply chamber provided with a cylindrical chamber E, a piston chamber A, oil chamber C, and pipes leading from the chamber C to the valve chamber D, substantially as and for the purpose described. (3) In an ice machine, a valve-receiving plate D′, provided with valves D^3 and D^4, in

337,874.



combination with a piston C′, and its lead cap secured to the top portion thereof, substantially as and for the purpose described. (4) An ice machine provided with the cylinder A, jacket A^2, surrounding the same to form an annular space A^3, and the pipes communicating with said space, and a valve chamber and oil chamber at the top and bottom of the cylinder, substantially as and for the purpose set forth. (5) In an ice machine, a double-walled pump cylinder, a gas chamber between them provided with a glass gauge G′, an oil chamber receiving the lower end of said gauge, and a pressure-regulating pipe g at the bottom, in combination with an oil-intercepting cylinder F, provided with a glass gauge F^2, an oil-discharging pipe F^3 at the bottom, and an inlet pipe E^3, and an outlet pipe F′, located at the top of the oil-intercepting cylinder, substantially as and for the purpose described.