AN INVESTIGATION INTO THE INTERNAL STRESSES OCCURRING IN CAST IRON AND STEEL.

By GENERAL NICHOLAS KALAKOUTZKY.

No. I.

Determination of the influence of internal stresses on the strength of materials.—We call internal stresses those which exist within the mass of any hollow cylinder or other body, when it appears to be in a state of repose, or not under the influence of external forces. When pressure is applied to a hollow cylinder, either externally or internally, the interior layers into which its walls may be conceived to be divided are subjected to a new series of stresses, the magnitude of which is independent of those already existing; these additional stresses combine with the former in such a manner that at every point of the thickness of the cylinder they have common resultants acting in various directions. Thus, if we call t the internal stress existing at a distance r_x from the axis of the cylinder, and in a direction tangential to its cross-section, and T the additional stress due to pressure inside the cylinder acting at the same point and in the same direction, then the newly developed stress will be $t + T$.

If R and r_o be the external and internal radii of the cylinder, and if we suppose the external pressure *nil*, then, if the pressure inside the bore be P_o, the stress on the radius r_x is determined by the following expression deduced from the well-known fundamental formulæ of Lamé[1]:—

$$T = P_o \frac{r_o^2}{R^2 - r_o^2} \cdot \frac{R^2 + r_x^2}{r_x^2}$$

From which we see that T is a maximum when $r_x = r_o$, *i.e.*, for the layer immediately next to the bore of the cylinder. Calling t_o the internal stress in this layer, and T_o the stress resulting from the action inside the bore of the pressure P_o, and allowing that the sum of both these quantities must not exceed the elastic limit U of the material, we have—$T_o = U - t_o$. And for this value of T_o, the corresponding pressure inside the bore will be

$$P_o = (U - t_o) \frac{R^2 - r_o^2}{R^2 + r_o^2}$$

This pressure increases with the term $(U - t_o)$. With t_o positive, *i.e.*, when the internal stresses in the thickness of the hollow cylinder are such that the metal of the layers nearest to the bore is in a state of tension, and that of the outer layers in a state of compression, then the cylinder will have the least strength when t_o has the greatest numerical value. Such stresses are termed injurious or detrimental stresses. With t_o negative the strength of the cylinder increases with the numerical value of t_o, and those stresses which cause compression in the layers nearest to the bore of the cylinder and tension in the outer layers are termed beneficial or useful stresses.

For these reasons, and in order to increase the power of resistance of a cylinder, it is necessary to obtain on the inner layer a state of initial compression approaching as nearly as possible to the elastic limit of the metal. This proposition is in reality no novelty, since it forms the basis of the theory of hooped guns by means of which the useful initial stresses which should be imparted to the metal throughout the gun can be calculated, and the extent to which the gun is thereby strengthened determined. The stresses which arise in a hollow cylinder when it is formed of several layers forced on one upon another, with a definite amount of shrinkage, we call the stress of built-up cylinders, in order to distinguish them from natural stresses developed in homogeneous masses, and which vary in character according to the conditions of treatment which the metal has undergone. If we conceive a hollow cylinder made up of a great number of very thin layers—for instance, of wire wound on with a definite tension—in which case the inner layer would represent the bore of the gun, then the distribution of the internal stresses and their magnitude would very nearly approach the ideally perfect useful stresses which should exist in a homogeneous cylinder; but in hollow cylinders built up of two, three, and four layers of great thickness, there would be a considerable deviation from the conditions which should be aimed at.

The magnitude of the stresses in built-up cylinders is determined by calculation, on the presumption that initial stresses do not exist in the respective layers of the tube and of the hoops which make up the walls of the cylinder. Nevertheless Rodman, as early as the year 1857, first drew attention to the fact that when metal is cast and then cooled, under certain conditions, internal stresses are necessarily developed; and these considerations led him, in the manufacture of cast iron guns, to cool the bore with water and to heat the outside of the moulds after casting. Although Rodman's method was adopted everywhere, yet up to the present time no experiments of importance have been made with the view of investigating the internal stresses which he had drawn attention to, and in the transition from cast iron to steel guns the question has been persistently shelved, and has only very lately attracted serious attention. With the aid of the accepted theory relating to the internal stresses in the metal of hooped guns, we can form a clear idea of the most advantageous character for them to assume both in homogeneous and in built-up hollow cylinders. In proof of this, we can adduce the labours of Colonels Pashkévitch and Duchêne, the former of whom published an account of his investigations in the *Artillery Journal* for 1884—St. Petersburg—and the latter in a work entitled "Basis of the Theory of Hooped Guns," from which we borrow some of the following information.

The maximum resistance of a tube or hollow cylinder to external stresses will be attained when all the layers are expanded simultaneously to the elastic limit of the material employed. In that case, observing the same notation as that already adopted, we have—

$$P_o = T \frac{R - r_o}{r_o} \quad \ldots\ldots \quad (1)$$

But since the initial internal stresses before firing, that is previous to the action of the pressure inside the bore, should not exceed the elastic limit,[2] the value of R will depend upon this condition.

In a hollow cylinder which in a state of rest is free from initial stresses, the fibre of which, under fire, will undergo the maximum extension, will be that nearest to the internal surface, and the amount of extension of all the remaining layers will decrease with the increase of the radius. This extension is thus represented—

$$t_x{}^1 = P_o \frac{r_o^2}{R^2 - r_o^2} \cdot \frac{r_x^2 + R^2}{r_x^2}.$$

Therefore to obtain the maximum resistance in the cylinder, the value t_x of the initial stress will be determined by the difference $T - t'_x$, and since P_o is given by Equation (1), then

$$t_x = T\left(1 - \frac{r_o}{R_o + r_o} \cdot \frac{r_x^2 + R^2}{r_x^2}\right) \quad . \; . \quad (2)$$

The greatest value $t_x = t_o$ corresponds to the surface of the bore and must be $t_o = -T$, therefore

$$\frac{r_o^2 + R^2}{r_o(R + r_o)} = 2$$

whence $P_o = T\sqrt{2} = 1{\cdot}41\,T$.

From the whole of the preceding, it follows that in a homogeneous cylinder under fire we can only attain simultaneous expansion of all the layers, when certain relations between the radii obtain, and on the assumption that the maximum pressure admissible in the bore does not exceed 1·41 U.

Equation (2) may be written thus—

$$t_x = T \frac{R}{R + r_o} \cdot \frac{r_x - R\,r}{r_x^2} \quad . \; . \quad (3)$$

Substituting successively $r_x = r_o$ and $r_x = R$, we obtain expressions for the stresses on the external and internal radii—

$$t_R = T\frac{R - r_o}{R + r_o} \text{ and } t_{r_o} = -T\frac{R}{r_o}\frac{R - r_o}{R + r_o}$$

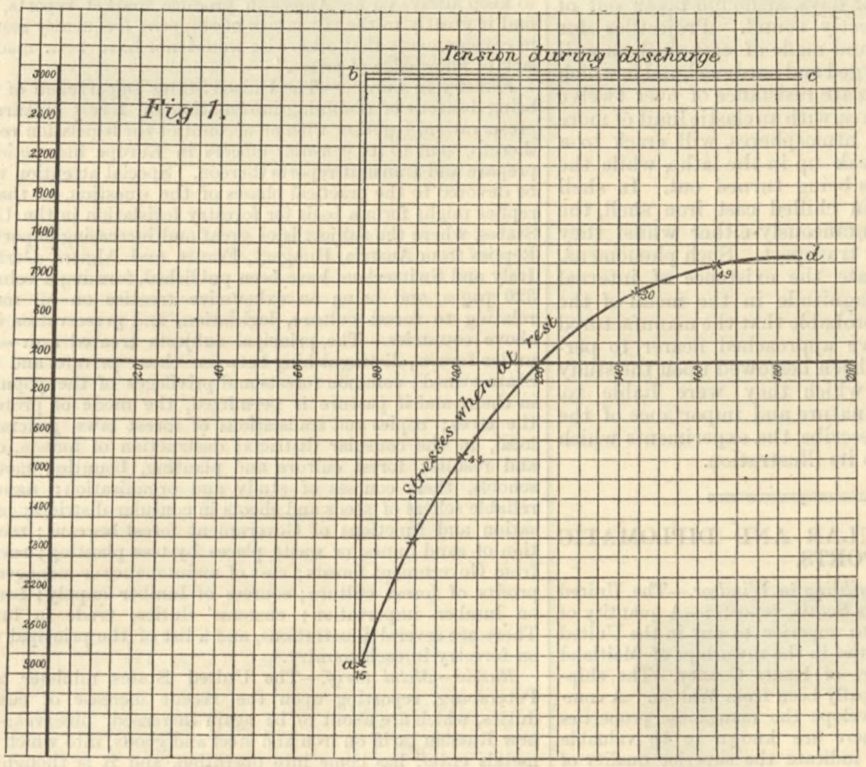
Therefore, in a homogeneous hollow cylinder, in which the internal stresses are theoretically most advantageous, the layer situated next to the bore must be in a state of compression, and the amount of compression relative to the tension in the external layer is measured by the inverse ratio of the radii of these layers. It is further evident that the internal stresses will obey a definite, but very simple law, namely, there will be in the hollow cylinder a layer whose radius is $\sqrt{R\,r_o}$, in which the stress is *nil*; from this layer the stresses increase towards the external and the internal radii of the cylinder, where they attain a maximum, being in compression in the internal layers and in tension in the external ones.

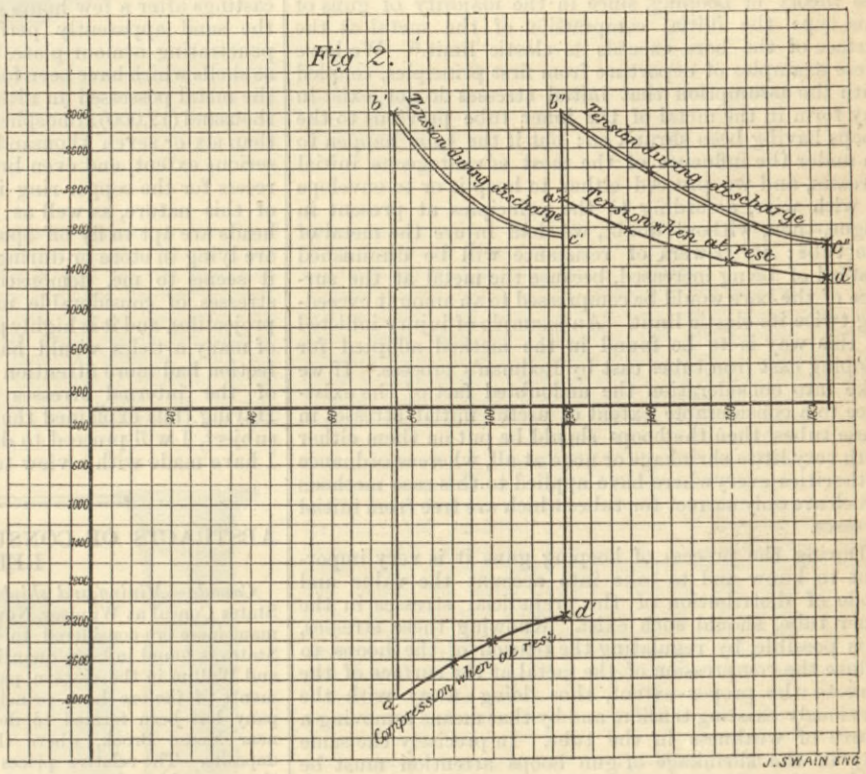
The internal pressures corresponding to these stresses may be found by means of very simple calculations. The expression for this purpose, reduced to its most convenient form, is as follows:—

$$p_x = T\frac{R}{R + r_o}\left(\frac{R}{r_x} - 1\right)\left(1 - \frac{r_o}{r_x}\right) \quad . \; . \; . \quad (4)$$

In order to represent more clearly the distribution of stresses and pressures in the metal of a homogeneous ideally perfect hollow cylinder, let us take, as an example, the barrel of a 6in. gun—153 mm. Let us suppose T = 3000 atmospheres; therefore, under the most favourable conditions, P_o = 1·41 T, or 4230 atmospheres. From Equation (1) we determine R = 184·36 mm. With these data were calculated the internal stresses and the pressures from which the curve represented in Fig. 1 is constructed. The stresses developed under fire with a pressure in the bore of 4230 atmospheres are represented by a line parallel to the axis of the abscissæ, since their value is the same throughout all the layers of metal and equal to the elastic limit 3000 atmospheres. If, previous to firing, the metal of the tube were free from any internal stresses, then the resistance of the tube would be $P_o = U\frac{R^2 - r_o^2}{R^2 + r_o^2}$, or 2115 atmospheres—that is, one-half that in the ideally perfect cylinder. From this we perceive the great advantage of developing useful initial stresses in the metal and of regulating the conditions of manufacture accordingly. Unless due attention be paid to such precautions, and injurious stresses be permitted to develope themselves in the metal, then the resistance of the cylinder will always be less than 2115 atmospheres; besides which, when the initial stresses exceed a certain intensity, the elastic limit will be exceeded, even without the action of external pressures, so that the bore of the gun will not be in a condition to withstand any pressure, because the tensile stress due to such pressure, and which acts tangentially to the circumference, will increase the stress, already excessive, in the layers of the cylinder; and this will occur, notwithstanding the circumstance that the metal, according to the indications of test pieces taken from the bore, possessed the high elastic limit of 3000 atmospheres.

In order to understand more thoroughly how the difference of the law of distribution of useful internal stresses as applied to homogeneous or to built-up cylinders, let us imagine the latter having the external and internal radii of the same length as in the first case, but as being composed of two layers—that is to say, made up of a tube with one hoop shrunk on under the most favourable conditions—when the internal radius of the hoop = $\sqrt{R\,r_o}$ or 118·7 mm., Fig. 2, has been traced, after calculating, by means of the usual well-known formulæ, the amount of pressure exerted by the hoop on the tube, as well as the stresses and pressures inside the tube and the hoop, before





[1] Lamé holds that in a homogeneous tube subjected to the action of two pressures, external and internal, the difference between the tension and the compression developed at any point of the thickness of the tube is a constant quantity, and that the sum of these two stresses is inversely proportional to the square of the radius of the layer under consideration. Let r_o, R, and r_x be the respective radii, p_o, p^1, and p_x the correspondding pressures, and T_o, T^1, and T_x the tensions, then we have:—

$$T_o - p_o = T_x - p_x \quad \ldots\ldots \quad (1)$$
$$(T_o + p_o)\,r_o^2 = (T_x + p_x)\,r_x^2 \quad \ldots\ldots \quad (2)$$
$$T_x - p_x = T^1 - p^1 \quad \ldots\ldots \quad (3)$$
$$(T_x + p_x)\,r_x^2 = (T^1 + p^1)\,R^2 \quad \ldots\ldots \quad (4)$$

If the radii are known and p and p^1 be given, then deducing from the above equations the values T_o and T^1, and also the variable pressure p_x, we determine—

$$T_x = \frac{p_o\,r_o^2\,(R^2 + r_x^2) - p^1\,R^2\,(r_x^2 + r_o^2)}{(R^2 + r_o^2)\,r_x^2}$$

This is the formula of Lamé, from which, making $p^1 = o$, we obtain the expression in the text.

[2] We must, however, remark that in a built-up hollow cylinder the compression of the metal at the surface of the bore may exceed the elastic limit; this cannot occur in the case of natural stresses.

and after firing. A comparison of these curves with those on Fig. 1 will show the difference between the internal stresses in a homogeneous and in a built-up cylinder. In the case of the hooped gun, the stresses in the layers before firing, both in the tube and in the hoop, diminish in intensity from the inside of the bore outwards; but this decrease is comparatively small. In the first place, the layer in which the stresses are = 0 when the gun is in a state of rest does not exist. Secondly, under the pressure produced by the discharge, all the layers do not acquire simultaneously a strain equal to the elastic limit. Only two of them, situated on the internal radii of the tube and hoop, reach such a stress; whence it follows that a cylinder so constructed possesses less resistance than one which is homogeneous and at the same time endowed with ideally perfect useful initial stresses. The work done by the forces acting on a homogeneous cylinder is represented by the area *a b c d*, and in a built-up cylinder by the two areas *a′ b′ c′ d′* and *a″ b″ c″ d″*. Calculation shows also that the resistance of the built-up cylinder is only 3262 atmospheres, or 72 per cent. of the resistance of a homogeneous cylinder. By increasing the number of layers or rows of hoops shrunk on, while the total thickness of metal and the calibre of the gun remains the same, we also increase the number of layers, participating equally in the total resistance to the pressure in the bore, and taking up strains which are not only equal throughout, but are also the greatest possible. We see an endeavour to realise this idea in the systems advocated by Longridge, Schultz, and others, either by enveloping the inner tubes in numerous coils of wire, or, as in the later imitations of this system, by constructing guns with a greater number of thin hoops shrunk on in the customary manner. But in wire guns, as well as in those with a large number of hoops—from four to six rows and more—the increase in strength anticipated is acknowledged to be obtained in spite of a departure from one of the fundamental principles of the theory of hooping, since in the majority of guns of this type the initial compression of the metal at the surface of the bore exceeds its elastic limit.[3] We have these examples of departure from first principles, coupled with the assumption that initial stresses do not exist in any form in the metal of the inner tube previous to the hoops having been shrunk on; but if the tube happen to be under the influence of the most advantageous initial stresses, and we proceed either to hoop it or to envelope it with wire, according to the principles at present in vogue, then, without doubt, we shall injure the metal of the tube; its powers of resistance will be diminished instead of being increased, because the metal at the surface of the bore would be compressed to an amount exceeding twice its elastic limit. An example of injury inflicted in this way is to be found in the method adopted for hooping cast iron tubes cast by Rodman's process.* If we take into consideration the undoubted fact of the existence to a considerable extent of useful initial stresses in these tubes, then the hoops should be put on them either with very little shrinkage or none at all, whereas ordnance authorities everywhere have applied to this case methods which are only correct for tubes which are free from initial stresses.

During the process of hooping guns it is very important to know and to take into account the value and mode of distribution of the prejudicial stresses in the inner tube, should such exist. Knowing these stresses, it is possible, by regulating the tension of the hoops, to reduce the compression of the metal at the surface of the bore to the proper extent, thus doing away with the previously existing tension, and by that means removing a source of weakness in the tube. In precisely the same way in the shrinkage of gun hoops attention must be paid to the character and value of the stresses which arise in the course of their manufacture; otherwise it will be impossible to hoop the barrel throughout in a proper manner. If prejudicial stresses exist in the metal of a hoop before it is put in its place, then, when the gun is fired, if it had been shrunk on with the degree of tension usually allowed the layer situated in the internal radius will be extended beyond admissible limits, thereby causing the resistance of the gun to be less than that prescribed.[4]

It is evident, from what has been said, that in order to determine precisely the resistance of hollow cylinders to internal pressures, and to make the correct calculations for hooping tubes, it is absolutely necessary to know whether internal initial stresses exist in the tube and in the hoops, and to ascertain what their nature and intensity may be—that is to say, whether they are useful or detrimental, yet it is incontestable that in the construction of modern ordnance no attention has been paid to the investigations indicated. If it be possible to ignore these considerations in the manufacture of guns of small calibre, and where the thickness of metal is not sufficiently great to admit of strongly developed internal stresses, such is by no means the case with the colossal and costly weapons of the present day. In these the thickness of metal in the tube and hoops is very great; hence the extreme probability of very considerable internal stresses developing themselves. That the strength of large guns is often far below that anticipated is demonstrated, year by year, by the repeated cases of failure. Consciousness as to the want of strength in such guns is made evident by the precautionary measures as to their use everywhere adopted. The heavy artillery produced in the gun factories of Europe is constructed with all the skill, science, and experience which engineers and artillerists can command, and therefore it would seem that instances of defective strength should not arise. Such cases, however, do occur everywhere, and irresistibly give rise to the suspicion that not only is the system of construction of guns of large calibre faulty, but also that the conditions of their manufacture must be considered as defective. Bearing in mind the enormous sums of money expended by every nation in order to secure an armament of completely trustworthy guns, this question demands speedy and searching investigation. The first step in this direction is the study of the internal stresses inherent in the metal; because, if such exist, and are capable of attaining, under certain conditions, considerable magnitudes, then it is absolutely necessary to take advantage of them in order to increase the resistance of the metal, instead of allowing them to act to its detriment.

The study of natural internal stresses is of importance not only with reference to gun-making, but also in respect of other structures where great resistance is required. All have heard of the sudden failure of crank shafts and piston-rods, of the bursting of boiler shells and tubes, of the breaking of tires, &c. In the majority of cases the investigations into the causes of such sudden failures have not led to any definite results. It has usually been found that the metal possessed a satisfactory elastic resistance, and satisfied all the conditions set down in the in the specifications. Had attention been paid during these investigations to the state of the internal stresses in the metal, the cause of unlooked-for accidents might have been explained, and steps would consequently have been taken to avoid them in future.

We are also familiar with the development of considerable internal stresses in various kinds of steel articles which are subjected to hardening and tempering; for example, as dies, tools of various description, sword blades, and thin plates rolled at a low temperature or subjected to cold hammering. In the foundry the appearance of internal stresses is of still more frequent occurrence. The neglect of certain practical rules in casting, and during the subsequent cooling, leads to the spontaneous breakage of castings after a few hours or days, although taken out of the sand apparently perfectly sound. Projectiles for penetrating armour-plate, and made of cast steel, as well as shells which have been forged and hardened, and in which the metal possessed an ultimate resistance of over twelve thousand (12,000) atmospheres, with an elastic limit of more than six or seven thousand atmospheres, will crack to a serious extent, and even break up in the lathe, while the recess for the copper ring is being turned out. In shell of this nature, as well as in chilled cast iron shell, the heads are apt to fly off spontaneously either whilst they are lying in store or during transport. Such phenomena, it seems to me, demonstrate the existence of internal stresses of considerable magnitude in the metal of the projectiles, and it is highly probable that the manufactured of many articles would have approached nearer to perfection had more attention been bestowed upon the study of the internal stresses which they were liable to. Having thus explained the nature and importance of the subject, I will proceed to describe the experiments which I have made with a view to its illustration.

[3] In certain cases this, of course, may be an advantage, as, for instance, when the inner tube is under injurious initial stresses; but then, in order to be able to apply the necessary shrinkage, we must know the magnitude of these stresses.

[4] When the inner tube is strengthened by means of wire, the initial or natural stresses in the latter may be neglected on account of its thinness, but when the thickness of the hoops is reduced, and the number of layers thereby increased, then the value of the initial stresses in these hoops is a very important factor with respect to the decrease or increase of the powers of resistance of the gun.

ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS.

Canada—Mining and shipbuilding in Windsor.—The United States Consul at Windsor, Nova Scotia, reports:—A quantity of manganese ore considered to be superior to any in the United States is found in large quantities in the townships of Maitland and Walton in the eastern part of Hants County. The shipments of the ore have principally been from Walton. A company has been formed to develope the manganese properties near Moose Brook, where there are known to be valuable deposits. The relative prices indicate the superior quality of the ore shipped from this country. In Pittsburg, Pa., the quotations range from £2 1s. 6d. to £3 2s. 3d. a ton. At Walton the average declared value of this ore exported to the United States exceeds £14 16s. 3d. a ton. The further development of these valuable mines will be observed with interest, and a special report made thereon. Considerable interest has been excited by the discovery of antimony in Rawdon, Hants County. There is an extensive coal formation in Cumberland County, which is said to contain some of the richest coal mines in the province. The Boston Coal Mining Company intends to open its mines at River Herbert, whence it can ship coal by vessels in summer, and at all times by the Joggins railway, which will give the towns along the intercolonial a good supply. The Joggins mines are not far from those at Spring Hill, but the shipping place is in another direction, at Port Joggins, on Cumberland Basin. The Joggins Coal Mining Association has shipped during the fifteen years from 1871 to 1885 inclusive, 234,558 tons of coal, or an average per year of 15,637 tons. The output of coal during 1886 has been a little larger than for some years, and it is expected that the sale of coal will be increased when the Joggins railway is completed to the intercolonial, which it is expected will be shortly. The mines at Spring Hill produce a soft coal, which the company claims to be the best soft coal in America, particularly for domestic and locomotive purposes, and is also suitable for making coal gas. It is brought by rail to Parrsborough, where vessels are loaded, and as the price at the place of shipment is only 4s. 2d. per ton, the wonder is that the demand is not greater. The output capacity of the mine is 2000 tons per day; the capacity for shipping at the wharf at Parrsborough is about from 300 to 400 tons per day; vessels drawing from 16ft. to 18ft. of water can be loaded with dispatch. The shipments of coal by water from Parrsborough amounted to 40,508 tons against 26,205 tons in 1885, an increase of 50½ per cent. Of this increased quantity 15,950 tons, valued at 4s. 2d. a ton, were exported to the United States, a considerable increase over 1885, which was only 2843 tons. The output at the Spring Hill mines was 468,000 tons, an increase of 118,000 tons, or 34 per cent. over 1885. The output in December, 1886, was 43,026 tons. The number of hands employed was over 1000, and preparations were making for an increase of business. Owing to the working of these mines a great impetus has been given to that part of Cumberland County, the town of Spring Hill, has developed itself with surprising rapidity, and now eclipses in enterprise and population older towns. Coal miners at the Loggins mines are usually paid by the box or cube, and earn from 5s. 3d. to 8s. 4d. a day. At the Spring Hill mines, pitmen are paid 1s. 6¾d. per box, taking out from four to five boxes per day, and earning from 6s. 3d. to 7s. 10d. per day; surfacemen receive from 4s. 2d. to 5s. 3d. per day. Shipbuilding is an important and large industry in this district, and was begun about a century and a quarter ago, commencing with a little craft of 35 tons and advancing by intermediate stages to one of near 2600 tons, with all modern improvements and appliances. The cost of building wooden schooners, three-masted, of from 400 to 500 tons, copper fastened and completely fitted for sea, is about £8 4s. 6d. per ton. Square-rigged vessels of larger size can be built at a less cost per ton, viz., barques and ships of over 900 tons, copper fastened, with a full suit of, and some extra sails, having all the modern improvements in capstans, winches, windlasses, &c., to rate thirteen years at French Lloyds', can be built here at from £7 to £7 12s. per ton, with 4s. 2d. per ton additional for metal sheathing. Sails cost considerably less here than in the United States, although the sailcloth is obtained therefrom and a net duty of 5 per cent. *ad valorem* paid. The reduction is in the cost of labour. The total cost of a suit of sails ready to hand does not exceed 1s. 4d. per yard, while in New York the cost is 1s. 8d. per yard. The average rates of wages paid per day in the shipyards of Windsor and vicinity are—blacksmiths, 8s. 4d.; helpers, 5s. 3d.; caulkers, 9s. 5d.; helpers, 5s. 3d.; riggers, 9s. 3d.; helpers, 5s. 3d.; ship joiners, 7s. 4d.; shipwrights, 6s. 3d.; helpers 4s. 2d.; unskilled labourers, 4s. 2d.

Canada—Trade of London.—The U.S. commercial agent at London, Ontario, concludes an elaborate and exhaustive report on the trade of that district with:—"My own conception of my duties as Consul has led me to pay particular attention to the commercial interests and relations of the United States, and to find and keep open all existing trade, and wherever possible, to create new business and make room for more of our goods and productions. To this end, during the past year, I have written several hundred letters to inventors, manufacturers, merchants, and others, and in all cases have had pleasant acknowledgments and thanks, and generally they have acted upon my information, and have either sent agents over, or through me have opened negotiations with the parties here. A firm of American waterworks contractors are estimating on and tendering for £205,760 of work, solely through my introduction and assistance, as it was a field they had never before been in and knew nothing of its opportunities. I have also introduced several American inventions and patents, which seem to take very well. It is my rule to keep always on file American produce market reports, and I find it greatly to the advantage of shippers, frequently resulting in consignments that otherwise would not have been made for lack of knowledge of prices."

Forestry in Europe.—The United States Department of State being desirous of obtaining information on forest culture and preservation, together with an account of the legislation relating thereto, sent to its consular officers in Europe instructions to prepare and transmit reports thereon. Special attention was to be devoted to the practical phases of the question, so that the replies might form a basis for forestry legislation in the United States, where the subject is of great and increasing importance. Replies from Austria, Hungary, France and Algiers, Germany, Italy and Switzerland have been published, forming a volume of 320 pages, and being an exhaustive treatise on all matters relating to forest culture, legislation, and preservation in the above countries. The principal subjects treated are:—Areas under forests, distinguishing between those private and those State-owned; common forests and privileges of the population in them, and if pasture is permitted, the mode of protecting the trees; copies and translations of forest laws, general and local, in the consular districts; destruction of forests, causes and results; forest culture and planting, bounties, methods, schools, their courses of study and organisation; names of reliable sellers of seeds and shoots in consular districts; organisation and functions of Government forest bureaus; reclamation of sand dunes, or waste places by tree planting; revenues from Government forests; cost of maintenance or management; profits of forest culture; sources of lumber supply; bounties on lumber importation; customs' duties, trade in lumber. There are several illustrations, and a list of the principal works on forestry in each country.

Russia—Metal tariff.—The United States minister at St. Petersburg, reporting upon the recent increase of customs' duties, which are about to be again increased, observes:—The new Russian tariff on iron and steel and goods, into which these metals enter, has come into operation, and it is thought will considerably affect the foreign trade of the country. The object of the law is an increase of revenue, and to foster and protect the domestic industry of the Empire in all the products taxed. It is another step in the ruling that conceives that the Empire should supply all her wants within herself. As the trade of Russia with the United States has sunk almost to a minimum, it may have the result of discouraging hopes of any revival of that trade, but the effects may be very injurious to other countries. Germany has, hitherto, largely supplied the Russian market with manufactured ironware and tools. The Russians complain that these were largely of inferior material and workmanship, and that they were put on the market at such low prices that they drove out better wares to the great injury of the country. The peasants were not discriminating purchasers, and were likely to buy the cheapest goods. The new tariff is construed by the German press to have a special significance. The following, from an article in the *Cologne Gazette*, may be taken as a fair expression of German feeling and views:—"The new Russian customs' measure is an event of very serious importance—a blow directed against German industry within our own Empire as well as in Russia, where it will almost have an annihilating effect. Brutal measures of finance, like those which have just been carried out by the finance minister of Russia, cannot but re-act on her political relations to the neighbouring State against whom they are directed, and perhaps it will not be wrong of us to assume that they were expressly devised for this purpose. At any rate, these Russian measures have immensely strengthened the movement on foot among us for doubling the duties on foreign grain."

Switzerland—Trade of Geneva in 1886.—The U.S. Consul reports:—In several important particulars the commerce of this district shows an improvement upon the year preceding, but as the prosperity of Switzerland depends to an unusual degree upon the foreign market, both for its sales and supplies; and on the whole the situation is not very different from that of recent years. The most noticeable feature is the continuous decline in the prices of nearly all products, with the double result of an increase both in exports and imports. There is a remarkable increase in the importation of American products, among which are agricultural implements and tools of all sorts. Nearly all the hardware dealers make a speciality of American articles, and one establishment deals in nothing else. This decline in prices, if it makes the conditions of life easier for the consumer, is naturally disquieting to the producer, as it means a competition of very wide extent, which he finds harder every day to resist, and to which he sees no limits. It is to be said, to the credit of manufacturers here, that they are trying to meet the difficulty by improving the method, as well as by diminishing the cost of production. A more questionable experiment is the attempt to arrest the decline by agreements of the manufacturers to fix a

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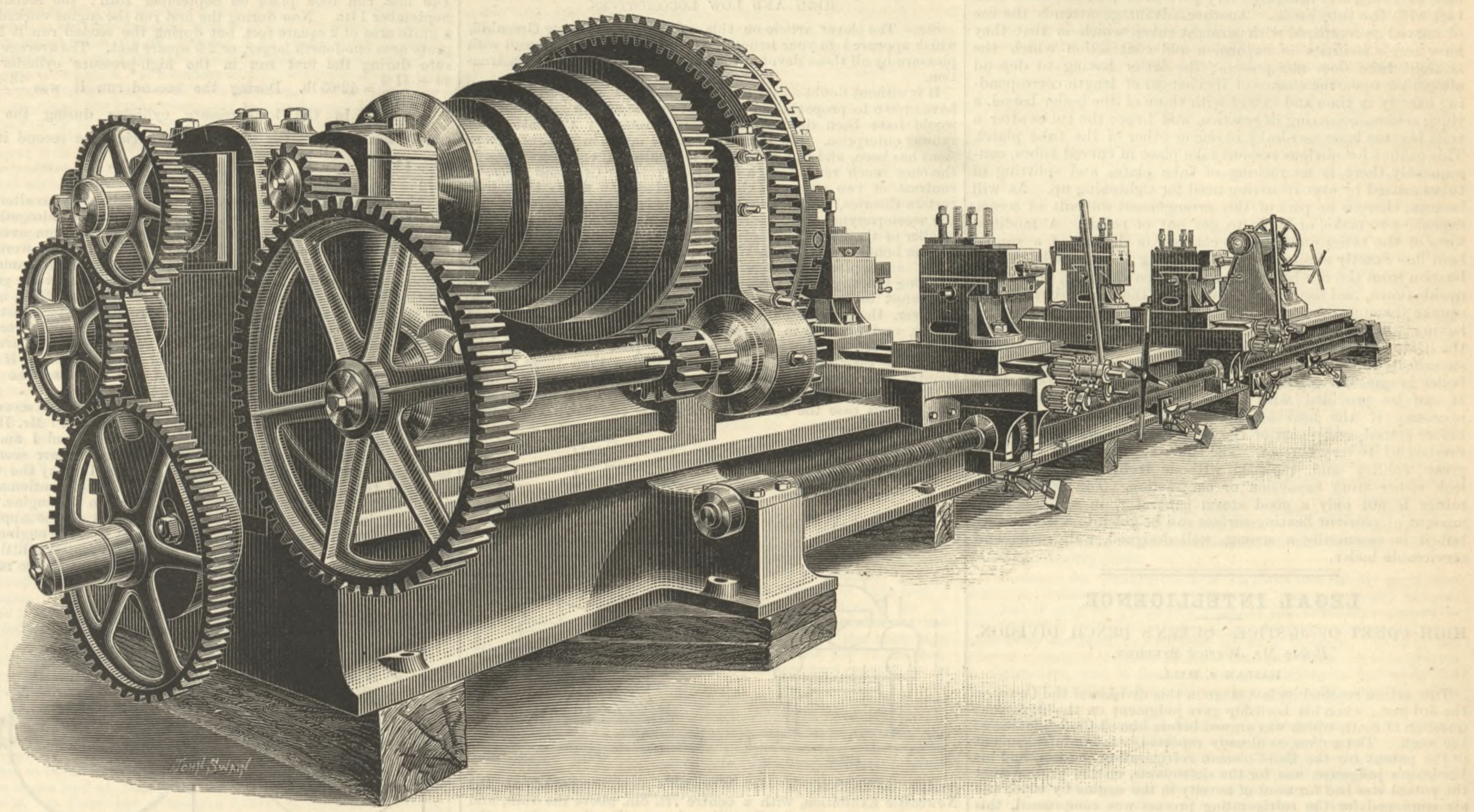
MESSRS. HULSE AND CO., MANCHESTER, ENGINEERS.



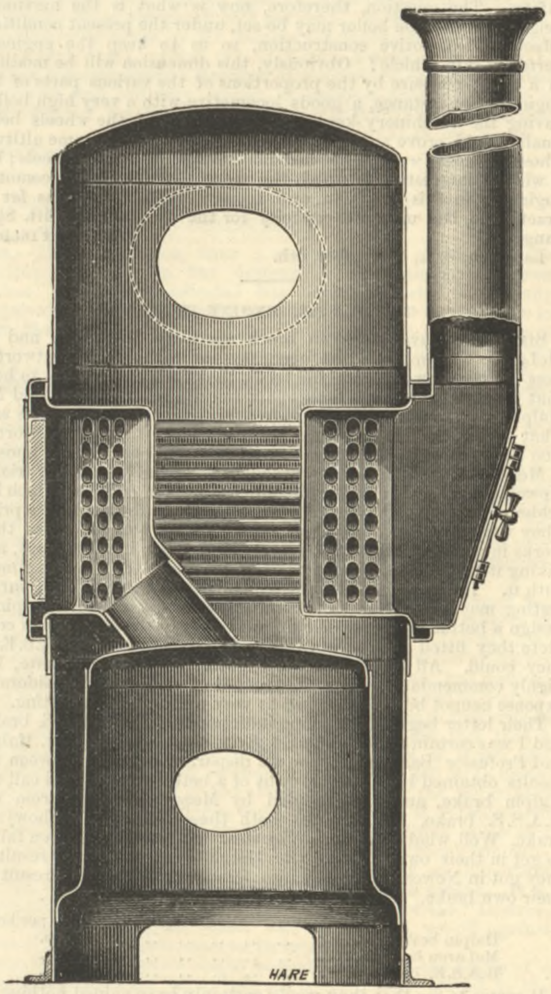
scale of minimum prices for the various grades of goods. At best this can only avert the effects of competition at home, a small matter, since there is no considerable home market, while it forbids the individual manufacturer from meeting effectively competition abroad. The moment a minimum price is fixed here on an article—say, for example, a particular variety of Swiss watch—the American or English maker, having his work cut out for him, has only to put on the market a like article at a lower price. In addition to the growing burden of taxation in this canton, due to the extensive works of public utility now in construction, the Federal Government is growing more costly. The new Customs tariff covers every article of import, and although in many cases the rates are merely nominal, in others they are high enough to have the effect of a protective duty. On the whole, the superiority of the Swiss to his over-burdened neighbours is not what it was a few years ago."

PATENT LATHE FOR SURFACING, SCREW-CUTTING, AND TAPER-TURNING.

OUR illustration is taken from a photograph of a 40in. centre, patent duplex sliding, surfacing, screw-cutting, and taper-turning lathe, made by Messrs. Hulse and Co., of Manchester. This lathe has four cutting tools carried by two sliding carriages and duplex compound slide rests, and propelled by twin guide screws. One special feature is the massive and powerful character of the lathe, which may be gathered from the fact that it will operate objects 60ft. in length and 5ft. in diameter. The sliding carriages are propelled simultaneously at the opposite sides of the bed, by which arrangement any cross strain is reduced to the minimum, and great steadiness is imparted to the cutting operations. The guide screws for traversing the carriages do not rotate, but remain stationary, the nuts under the carriage being made to rotate instead. By this means the two sliding carriages, or in fact any number of carriages that may be placed on the bed of the lathe, can be made to traverse in either direction quite independently of each other, which is obviously a considerable advantage over the rotating screws in ordinary lathes, which only allow of the carriages being traversed in one direction, viz., either all towards the fast head-stock or away from it. Each of the four tools in ordinary working takes a cut of 1½in. deep and over ⅛in. feed, which, at the ordinary cutting speed for steel, is equal to about 5 cwt. of cuttings per hour, or ten tons for the four tools per day of ten hours. The vees of the slide rests at the back of the lathe are inverted in order to cope satisfactorily with the upward pressure of the cut. Each carriage is fitted with independent mechanism for taper turning, which, by an arrangement of worm wheels, gives any required taper from one in six to one in one hundred. The fast head-stock is very powerfully geared, and has twelve different changes of speed. The spindle is of crucible cast steel, and provided with multiple surfaces to take the end thrust. The face-plate is over 7ft. diameter, with internal and external gear at the back, and provided in front with four massive steel jaws for gripping the work. The movable head-stock is also of great strength, and the spindle has a quick traverse by hand wheels, and a slow traverse by worm and wheel for forcing the centre into the work. Lathes of the above description have now, we believe, been applied to the leading works in Sheffield and the North, where massive steel ingots and gun and propeller shaft forgings have to be dealt with, and are working with very satisfactory results.

THE ESSEX VERTICAL BOILER.

PROBABLY no type of steam generator is so susceptible of variety of design, or is at present to be found with such a diversity of internal arrangement, as is the vertical boiler. Nor is this to be wondered at. Easily moved about, occupying little space, needing no brick setting, and if properly designed, capable of sustaining considerable pressures with safety, it is a most useful type. Until, however, the year 1870, when Messrs. Davey, Paxman, and Co., created a sensation at the Royal Agricultural Society's Show at Oxford by the extraordinary performances of a vertical boiler exhibited for the first time there by them, little attention was given to its improvement, and it deserved and received little use. Up to that time only one good vertical boiler, namely, the Field, was in the market. Although a great many had been invented, none of them had received much popular approval. The vertical boilers in regular use either had only a few cross tubes put through the fire-box, or the fire-box was coupled to the smoke-box by a number of vertical tubes. Messrs. Davey, Paxman, and Co. then demonstrated to the engineering world that it was just as practicable to make a good vertical steam producing boiler as of any other type.



THE ESSEX BOILER.

The Oxford boiler was fitted with water tubes descending from the top of the fire-box, some distance towards the fire, and turning off to and secured in the sides of the box, and to prevent the upward rush of steam and water causing priming, they fitted the mouths of the tubes above with defectors. The earliest forms of the vertical boiler were really nothing more than a short Lancashire boiler set up on end, and the part of the internal flue above the fire contracted in diameter; while succeeding designs did away with a single upcast flue, substituting instead thereof a number of tubes. In either case but a very small portion of this heating surface being covered with water, the remainder therefore was useless as a steam generator Time changes all things, and the vertical boiler of the present day may be found in many kinds of design.

Many points have to be considered in designing a good vertical boiler, and here, as in sundry other engineering subjects, mere high theory travels not always with practical exigency; and in such case the former must of necessity give place to the latter. Thus, in theory the heated gases should impinge upon or travel over metallic surfaces till nearly all their contained heat shall have been absorbed by the water at the other side of the plate, only heat enough being left in the gases to maintain efficient draught in the uptake, and probably spiral tubes, or those bent and twisted in fantastical shapes, by incessantly deflecting the hot gas currents, would be most efficient for this; but practical considerations of keeping the tubes swept, easily removing defective or worn-out tubes, perfect accessibility to all parts, non-liability to get out of repair, and power to effect repairs cheaply and rapidly. All these are matters quite as important as great evaporative efficiency. The steam generator most useful is that which, while giving a good evaporation, will work all the year round without needing especial care and highly-skilled attendance, can be made and sold to steam users at a reasonable price, and whose maintenance cost shall be low. Messrs. Davey, Paxman, and Co.'s new Essex boiler, as here illustrated, may fairly claim to comply with the conditions above enumerated. It may be described as follows:—The products of combustion are conducted from the fire-box by a central flue bent at an angle and opening into a combustion chamber of a shape somewhat resembling the letter V, the apex being rounded to a considerable radius. This is put horizontally into a suitable hole, made in one side of the boiler, and being flanged is rivetted securely to the boiler shell. This chamber is in fact a box, two of whose sides taper towards each other to the centre of the box, while the other two sides are parallel. When in position the tapering sides are radial from the centre to the shell of the boiler and vertical. Into each of the radial sides of this chamber a number of tubes are fixed, as in the tube plates of any type of multitubular boiler, and these tubes are curved round in segments of a circle whose radii are greater than the semi-diameter of the shell. A similar box is fixed in the boiler on the same level with but just opposite to the combustion chamber, and may be conveniently designated the smoke-box and the other ends of the tubes are set in its side plates in the same way.

The combustion chamber is closed by a suitable door lined with fire lumps, which gives ready access to the tubes for sweeping. The smoke-box is closed by a cover, to which the uptake is secured. The combustion and smoke-box chambers are made of the very best mild steel, pressed out, including the flange, in one piece. This is one of the best pieces of stamping work we have ever seen. It has been so carefully and thoroughly worked out that no reduction of area takes place, and the plate is of uniform thickness throughout.

The bending of the tubes to a larger curve than that of the boiler shell enables them to be put in or withdrawn individually, without disturbing any other part. A little consideration will show that Messrs. Davey, Paxman, and Co., have ingeniously contrived to attain, in a great measure, that breaking up and "eddying" of the heated currents causing them to impinge more directly upon the heating surface parts, which is necessary to secure the largest possible portion of the heat for the generation of steam. The natural tendency of currents is to move in straight lines. To get considerable power out of a relatively small boiler, fuel combustion must be rapid; and this entails the evil of a speed so great for the heat currents, that when passing through straight tubes, sufficient time is not allowed them to give up their heat for steam generation. Where bent tubes are used, as in the boiler under notice, the high speed of the heat currents becomes an advantage; because, from their tendency to move in straight lines, the resulting centrifugal action impels them against the outer and larger sides of the tubes with something like a blow-pipe action.

In the case, too, of heated gases passing along a straight tube the central and lower part of the contained gases in some cases will hardly reach the metal at all, and simply pass to the uptake with nearly all their heat retained. This cannot exist in such curved tubes as those under notice, where a constant impinging and recoiling action is going on, breaking up and mixing the heat currents, and bringing every portion of them in close contact with the tube metal. Another advantage attends the use of curved as compared with straight tubes, which is that they have ample facilities for expansion and contraction which the straight tube does not possess; the latter having to depend altogether upon the chance of its changes of length corresponding exactly in time and extent with those of the boiler barrel, a thing seldom occurring in practice, and hence the tubes after a time become loose and leaky in one or other of the tube plates. This cannot for obvious reasons take place in curved tubes, consequently there is no racking of tube plates and splitting of tubes caused by ever-recurring need for tightening up. As will be seen, there is no part of this arrangement difficult of access, expensive to make, or liable to get out of repair. A modified form of the boiler under notice consists in the use of a second bent flue exactly similar to that conveying the products of combustion from the fire-box to the combustion chamber, but turned upside down, and conveying them from the smoke-box to the uptake through the centre of the top of the boiler, instead of having it at the side as in the other form. This conveyance of the heated gases through the steam space helps also to dry and superheat the steam, which is a conspicuous advantage. The boiler in question appears to contain all the elements of success. It can be provided with large heating surface; which is necessary if the heat of the fuel is to be taken up. As before stated, every part of the boiler is easily got at—even the fire-box to its very bottom. The tubes can be taken out with great facility and replaced without trouble; they do not leak either from expansion or contraction. The boiler under notice is not only a good steam generator, in which a large amount of efficient heating-surface can be got into a little room, but it is essentially a strong, well designed, well made, and serviceable boiler.

LEGAL INTELLIGENCE.

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

Before Mr. Justice Stephen.

HASLAM *v.* HALL.

This action reached its last stage in this division of the Court on the 3rd inst., when his Lordship gave judgment on the important question of costs, which was argued before him at the beginning of the week. The action, as already reported, was for infringement of the patent for the Bell-Coleman refrigerating process, and his Lordship's judgment was for the defendants, on the ground that the patent was bad for want of novelty in the engine by which the air employed for the refrigerating process was compressed, this engine being the subject of a distinct claim in the specification.

Mr. Justice Stephen now said that he had considered the question of costs attentively, and it appeared to him that the only guides he had were the Act of 1883 and the cases which had been called the Badische case (29, Ch. Div., 366) and the Germ Milling case. After noticing the nature of these two cases, his Lordship went on to say that in the present case it was admitted by both parties that the defendants must get the general costs in the cause. Next, it was clear, on the authorities, that the plaintiffs must have the costs on the issue of infringement. Then came the difficult question of the costs on the issue of novelty. There were two entirely different parts of this machine—(1) the motive part of the machine by which the compressing pistons were worked; and (2) the parts by which the compressed air was used in the refrigerating process. The two were as far apart as two things could be. On the first, his Lordship had found that the patent was bad, and that ended the matter. On the second, the defendants had set up anticipation by other patents. On that it appeared to his Lordship that the plaintiffs entirely won and the defendants entirely failed. Mr. Moulton now asked that the defendants should have the entire costs of the issue, on the ground that the issue of novelty was one and indivisible, and that the defendants had succeeded on that issue. The Act said that "on taxation of costs regard shall be had to the particulars delivered by the plaintiff and by the defendant; and they respectively shall not be allowed any costs in respect of any particular delivered by them unless the same is certified by the Court or a Judge to have been proven or to have been reasonable and proper, without regard to the general costs of the case" (Patents, Designs, &c., Act, 1883, sec. 29, 6). Now, all the particulars delivered by the defendants, with one exception, had been disproved. As regards the one which was proved (numbered "T. T,") his Lordship would certainly certify. As to the others, Mr. Moulton had not satisfied him that the issue was one and indivisible. He thought the Act intended that the successful party should not have costs beyond what the Judge thought reasonable and proper in the case. It might have seemed reasonable from the defendants' point of view that they should set up these objections, but it certainly was not reasonable from the plaintiffs' point of view that they should have to pay for them when the defendants failed to prove them. Neither did his Lordship think they were proper, because it was not proper to put things on the record which you did not attempt to prove. Many of these objections were not mentioned at all during the trial, and others only had a remote bearing on the case. The result was that his Lordship certified that the defendants' particulars numbered "T.T." were reasonable and proper, but gave no certificate as to the others.

Mr. Carpmael, who was with the Attorney-General and Mr. Aston, Q.C., for the plaintiffs, asked his Lordship to certify under sec. 31 of the Act of 1883 that the validity of the patent came in question in the action.

Mr. Moulton, Q.C. (with him Mr. Bousfield), for the defendants, objected, but after a short discussion,

His Lordship certified as requested.

Junior Engineering Society.—A paper was read before this Society on "The Illumination of Lighthouses," by Mr. F. R. Taylor, who, in introducing the subject, briefly traced the development of the maritime signal from the primitive beacon to the elaborate lighthouses of the present time, and stated how great was the importance of efficient coast and other lights. The concentration of light by the catoptric and dioptric systems was considered and Fresnel's lenses described. Reference was also made to the catadioptric system, and Stevenson's prism reflectors were explained. An extended allusion to revolving and fixed lights, condensing and dipping apparatus, and apparent lights was made; and the relative efficiencies of oil, gas, and electricity as illuminants were discussed, their respective advantages under various circumstances being indicated. The paper was illustrated by aid of the Sciopticon. On the 2nd inst. a paper on "The Experimental Testing of Materials" was read by Mr. P. Marshall. The value of systematic testing was first mentioned, and the objects the experimenter had in view were cited. A description of the Werder and Wicksteed machines, and of specimens and specimen-holders, including those of Professor Kennedy and Mr. Martens, was given. The author referred to the measurement of elastic strains and to automatic diagram recording apparatus. Bailey's wire tester was described, and the method of experimenting with it explained, as was also Thurston's oil tester, and an apparatus for ascertaining the flashing point of oils. The testing of coals by an appliance for finding their evaporative power was alluded to, and cement testing was also considered. Specimens of some of the materials tested were exhibited at the meeting, and the paper was well illustrated by diagrams.

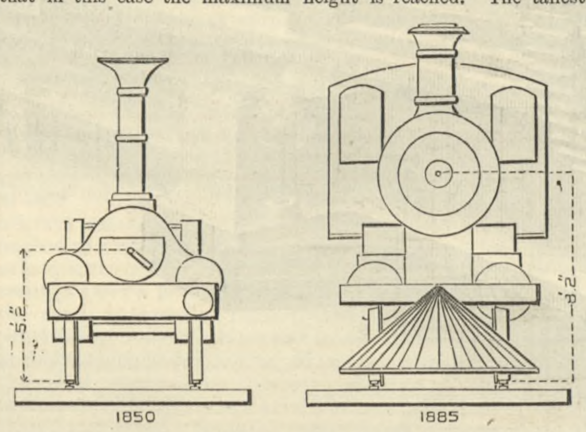
LETTERS TO THE EDITOR.

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

HIGH AND LOW LOCOMOTIVES.

Sir,—The clever article on this subject by Professor Greenhill, which appeared in your issue for December 2nd, will be read with pleasure by all those devoted to the science of locomotive construction.

It is without doubt a fact that, during the past few years, engines have grown to proportions—and that on the narrow gauge—which would have been deemed almost impossible by the fathers of railway enterprise. But the main feature in the increase of dimensions has been, and is, a noticeable inclination of engineers towards the once much reviled high boiler. Professor Greenhill shows a contrast of two engines exhibited in 1862, on which to deduce certain theories, but given a lapse of the last thirty-five years, and the accompanying sketch portrays an even greater difference. The smaller of these two locomotives is of the "Snake" class, running on the London and South-Western Railway about 1850, the other being an express passenger engine for the Pennsylvania and Reading Railway, built 1885. Who shall say which of these two is the safest to run and the steadiest to work? It is remarkable, however, that, although the American railways are of inferior laying, and abound in sharp curves, necessitating great super-elevation, yet, on the whole, during the past twenty years, the boilers of their engines have ranged higher than those in this country. The American engine here represented is pitched as high as 8ft. 2in. from boiler centre to rail level, and one would think that in this case the maximum height is reached. The tallest



1850 1885

engine in England is Mr. Worsdell's new compound at the Newcastle Exhibition, with a centre 7ft. 8in. above the rails, and yet we hear of no evil effect therefrom. On the contrary, the most casual observers cannot fail to notice the difference of running between a high and low boiler locomotive at any station on the London and South-Western Railway. The old engines, of the late Mr. Beattie's, shake from side to side and appear generally agitated whilst running, whilst those of Mr. Adams' immense types glide along as smoothly as can be desired. In both of these cases the conditions are much similar, *i.e.*, the wheels of same diameters and the cylinders outside, the new engines having the advantage under discussion of higher boilers and increased weight.

Thus Professor Greenhill proves what most modern engineers will endorse, that a high boiler locomotive will run more steadily and more economically, as regards wear and tear, both of itself and the permanent way, than a low boiler one; and I have shown to what height the boiler has been already pitched with absolute safety. The question, therefore, now is what is the maximum height to which the boiler may be set, under the present conditions affecting locomotive construction, so as to keep the engine a perfectly safe vehicle? Obviously, this dimension will be modified in a great measure by the proportions of the various parts of the engine. For instance, a goods locomotive with a very high boiler, having the machinery kept low on account of the wheels being small, would prove a steadier engine than one of the same altitude whose cylinders were positioned for driving 7ft. or 8ft. wheels; but it will be interesting to watch the steps taken by our locomotive engineers in this direction, and, meanwhile, to foresee, as far as practicable, the ultimate capacity for the same on the 4ft. 8½in. gauge.

Fredk. A. Field.

Lambeth, S.E., December 6th.

THE R.A.S.E. ENGINE TRIALS.

Sir,—You have given so much space to Messrs. J. and H. McLaren, who impeach the accuracy—or rather the trustworthiness—of the Newcastle engine trials, that I am encouraged to hope that you will spare me a little space to criticise what they and Mr. Halpin have said. I know nothing whatever about the facts save what appears in The Engineer of the 2nd inst., but the information supplied is copious to those who can read between the lines.

Messrs. McLaren sent a very excellent compound engine for trial to Newcastle, and with it they attained a pitch of economy which has seldom been equalled, not to say excelled. They did not take a prize. They were convinced that their engine, being turned out of their works in a great hurry, it was capable of much better things, and taking it home to Leeds, they began, very properly, to experiment with it. They held that the R.A.S.E. brake was not an accurate testing machine. They called in Professor Barr and Mr. Halpin to design a better brake for them, and to make the comparison complete they fitted up a second brake, as like that of the R.A.S.E. as they could. All this is not only quite fair and legitimate, but highly commendable. The experiment carried out at considerable expense cannot but be regarded as very useful and interesting.

Their letter begins with a long indictment of the R.A.S.E. brake, and I was certain that the figures given in the report of Mr. Halpin and Professor Barr would show a disparity, not only between the results obtained by what for want of a better word I shall call the Halpin brake, and that copied by Messrs McLaren from the R.A.S.E. brake, but between both these last and the showyard brake. Well, what do I find? Why this, that Messrs. McLaren failed to get in their own yard on the Halpin brake as high a result as they got in Newcastle. They also failed to get as high a result on their own brake. Here are the figures:—

	Coal per brake H.P. per hour.
Halpin brake..	2·11 lb.
McLaren brake	2·14 lb.
R.A.S.E. brake	2·08 lb.

It seems to me that they would certainly have gained nothing at Newcastle had Mr. Halpin's brake been substituted for that actually used.

Furthermore, I find that the result obtained with the presumably perfect Halpin brake differs from that obtained with the presumably imperfect McLaren brake amounts by ·03 of a pound of coal per brake horse-power per hour. In other words, the denounced brake is bad for the engine to this extent, that if in a certain time the engine developing a certain power burned 211 lb. with one brake, it would doing the same work in the same time burn 214 lb. with the other brake. Surely this is great cry and little wool. But let us go a little further. So far everything is straightforward and above board. Professor Barr and Mr. Halpin have told the truth, but not the whole truth. Are we to believe that after a considerable sum had been spent on brakes, &c., only two trials took place? I think not. If we examine the figures we shall find excellent reasons to conclude that the two runs of which particulars are given are selected runs taken out of several. I am led to this conclusion because as I have said, first, it is extremely improbable that so much money would be spent for the purpose of making two runs only; and, secondly, by the circumstance that alterations were made in the engine subsequent to the first run. The first run took place on September 13th; the second on September 14th. Now during the first run the engine worked with a grate area of 2 square feet, but during the second run it had a grate area one-fourth larger, or 2·5 square feet. The average pressure during the first run in the high-pressure cylinder was $\frac{44 + 41{\cdot}3}{2} = 42{\cdot}65$ lb. During the second run it was $\frac{48 + 33{\cdot}4}{2} = 40{\cdot}7$ lb. In the low-pressure cylinder during the first run it was $\frac{16{\cdot}4 + 17{\cdot}4}{2} = 16{\cdot}9$ lb., and during the second it was $\frac{15 + 15}{2} = 15$ lb.

This result could only have been brought about by an alteration of some kind in the valve gear. The engine worked altogether at a lower pressure. The revolutions during the first run averaged 145·7 per minute, and during the second 148·5. In one word, the two runs were not made as nearly as possible under the same conditions. As a further proof of an alteration in the valve gear, I see that in the second trial the boiler pressure was 142 lb., and in the first 140 lb., the highest boiler pressure giving the lowest total average cylinder pressure. Now why was this? Why were not the two trials made on the same basis? Will Messrs. McLaren say (1) whether there were or were not other runs made? (2) If there were, what were the results obtained? (3) Why was the grate area not kept the same in the two given?

Turning from Messrs. McLaren's letter to Mr. Halpin's second, or supplementary, report, I find matter for reflection. Mr. Halpin has found a mare's nest of unusual proportions, and I am very anxious to know how he found it. Professor Barr seems to have kept pretty carefully away from it, and I fancy the whole credit of the discovery is due to Mr. Halpin. This gentleman has found that the compensating levers put a load on the engine. The whole engineering world has been using brakes of the approved type for about half-a-century, and it turns out that the engineering world has been all wrong. Let me go into this matter a little: A, Fig. 1, is a wheel of any circumference—say 33ft.—caused to revolve

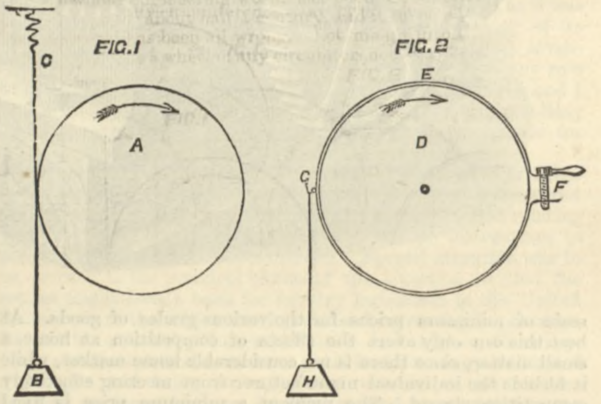


FIG. 1 FIG. 2

in the direction of the arrow by an engine. As it revolves it winds up the rope, and so lifts the weight B. If B weighs 1000 lb., and A makes one revolution per minute, we have 1-horse power, and for ten revolutions per minute 10-horse power, and so on; but it is clear that this would be an extremely inconvenient way to measure power. If, however, we could so arrange matters that the rope would not be actually wound up though the weight was kept suspended from the rim of the wheel, we should then have a convenient dynamometer. This can be done in two ways. If, for example, we wind the rope once round the wheel and make the end fast to a spring, as shown at C, we can easily so adjust matters that the weight will be kept just floating, so to speak, as long as the engine is running, and the work of the engine, instead of being done against gravity, will be expended in friction and heat between the rope and the wheel rim. This is, it will be seen, virtually Mr. Halpin's brake.

But we can attain the same end in another way. The tail end of the rope in Fig. 1 must be kept tight in order to set up friction enough between the cord and the weight; we may get this friction by the aid of a screw instead. Fig. 2 shows this. Here a hoop surrounds the wheel, and can be tightened by the hand-screw F. The weight H is hung from a hook on E at G.

Now, what I want to direct particular attention to is that there is a tension in the hoop due to the action of F, which has nothing at all to do with H, and is in no sense or way a load on the engine. Fig. 2 shows the R.A.S.E. brake without an addition, to which I shall refer in a moment. The tension in the hoop depends on the load H, and the coefficient of friction between the hoop and the wheel. In the R.A.S.E. trials it may amount to a ton or more.

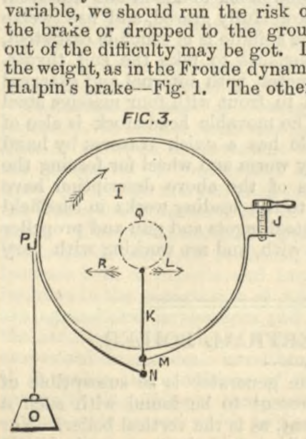
Now, what Mr. Halpin has done is to confound this hoop tension with the load against the engine.

I must ask your readers to admit that no force can re-act against an engine through a brake which would not also tend to cause the rotation of the brake wheel. Thus, for instance, if steam were shut off when an engine is running on the brake, the brake load would at once fall, pulling the brake wheel, and, of course, the crank shaft round with it. I do not think that the truth of this statement requires any demonstration. But, it is quite clear that no matter how great the tension of the brake strap may be, that tension cannot tend in any way to cause the rotation of the brake wheel, and consequently it is not a resistance.

Here it may be superficially urged that the end of a plank forced against a fly-wheel would act as a brake, and yet could not cause the rotation of the wheel. This is quite true, but what I say applies to Appold brakes with suspended resistance only.

Now let us see where Mr. Halpin's mare's nest comes in. If the brake were made as in Fig. 2, it would be impossible to work it in practice, because, as the equilibrium of the weight depends on the constancy of the co-efficient of friction, and as the co-efficient is variable, we should run the risk of having the weight pulled over the brake or dropped to the ground at any moment. Two ways out of the difficulty may be got. In one a spring is substituted for the weight, as in the Froude dynamometer, the Prony brake, and Mr. Halpin's brake—Fig. 1. The other depends on the use of compensating levers, as shown in Fig. 3. Here I is the brake-wheel, J the hand-screw, P suspension-hook, O the weight, K is one of two suspension-rods—one at each side of the wheel. These rods slide, and move loose in holes in brackets at L; one end of the hoop is secured at M, the other at N. It will be seen now that if the friction augments, and P tends to be carried up, as soon as it rises a little the hoop will be slackened, and its friction on the wheel reduced; and in the same way, if it tends to fall, the strap will be tightened. There is, by tightening the strap, a stress put on L in the direction of the arrow. But this is due *not to the motion of the wheel*, but to the stress in the strap, and in no way affects the work done by the engine.

FIG. 3.



Mr. Halpin fails to see this, and fancies that it does affect the engine. He overlooks the circumstance that the stress is static not dynamic; and that it is measured not by anything the brake wheel does, but by the tension of the strap, and it will vary continuously just as the strap tension varies, as the weight rises or falls. The levers K are intended to vary the tension in the strap. Mr. Halpin's mistake is due to the circumstance that it is quite possible to introduce a third element, which, however, is not introduced in practice, although he put it into the McLaren brake. I have put in a dotted line Q in Fig. 3. If a horizontal pull in the direction of the arrow R were put on L, it would tend, of course, to rotate L and the whole hoop round the brake wheel, and so help the engine; and this Mr. Halpin does by putting on springs. But in the R.A.S.E. brake there is, of course, nothing of this kind. The point L rests against a support; it is not pulled round. It is easy to reduce Mr. Halpin's proposition to an absurdity. In the first place, if the point L coincided with the centre of I, as there would be no radius, there would be no tendency to cause the rotation of the brake wheel, no matter how great the pull. But, furthermore, if the mere resting of the point L against a fixed stop, as it did at Newcastle, could cause the brake wheel to rotate, we should have perpetual motion at once, a static force producing a dynamic result.

If Mr. Halpin had a smaller reputation than he possesses, it would be unnecessary to take up so much space in refuting so obvious a blunder.

Turning again to his report, I find that by putting springs on to pull at L, he opposes his brake load to such an extent that, on his own showing, he has to augment it by over 100 lb. in order to get sufficient resistance. This is a very funny thing. The R.A.S.E. brake gives the proper resistance without any addition to the load; but it ought to be quite incapable of doing this, if Mr. Halpin is right. He actually has failed to see that he has behaved precisely as though, when a man weighed a ton of coals, he put in one scale the ton of coals and a cwt. weight, and in the other 21 cwt.

I have taken up a great deal of space, I fear, and much yet remains to be said, which I may, with your leave, say at another time. R. A. S.

Westminster, December 5th.

SIR,—I have read Messrs. McLaren's useful letter with much interest. Long as it is, it is so far incomplete that I am unable to understand it, and I venture to ask for further information through your pages.

In the report of the engineers contained in the last volume of the Society's "Journal," I find that during the trials at Newcastle the load on the brake was 265·75 lb., the revolutions per minute 149, and the circumference of the brake load circle 17·31ft.

During the trials carried out by Professor Barr and Mr. Halpin, I see that the circumference of the imitated R.A.S.E. brake was 17·5ft., or very nearly the same as the Newcastle brake; also the revolutions were nearly the same, the brake surface speed, indeed, being practically identical in both cases. I find, too, that the horse-power at Newcastle was 20·7 and at Leeds 19·1—not a great difference so far as I understand the results. What puzzles me is that the brake load at Leeds was 381 lb., or 116 lb. more than at Newcastle. Is there not a mistake here? If not, how does it happen that different loads gave the same results? Will your correspondents kindly enlighten me? L. ST. LAWRENCE.

Finsbury, December 7th.

SIR,—I am glad to see Messrs. M'Laren raising the whole question of the truth of the story told by brakes.

Some years ago Mr. Porter, who introduced the Allen engine into this country in 1862, carried out a series of experiments with brakes, and got some remarkable results, which were made public at the time, and which went to support Messrs. M'Laren's contention. I do not, I am sorry to say, remember where they were printed, but I rather think Mr. Wilson Hartnell, of Leeds, could throw some light on the matter. Possibly some of your readers can do the same. J.

Bolton, December 6th.

FREE TRADE AND NO TRADE.

SIR,—I must apologise for again trespassing on your space to answer some of the remarks on my previous letters, as I should be very sorry to leave them unanswered.

I said in my first letter that Mr. Giffen had made the discovery that our people are being freed from other industries as the result of our Free Trade policy. I did not say that he had pointed out these industries, but in due time they will without doubt be revealed. Pending this revelation, it seems likely that the industrial boom of the immediate future will be in relief works. The people so employed can be fed on cheap loaves until some other industry shall arise.

I am asked if I believe that the agricultural labourer is thankful for the cheap loaf. I say most emphatically, yes. He has the franchise, and could soon alter our fiscal system if he wished. But he is too intelligent, and so well grounded in the principles of political economy, that notwithstanding some of our professional leaders have lately been asking him which way they shall lead, they can get no strong indication of any departure from those principles.

I am told that the cheap loaf takes away employment from the agricultural labourer, and asked what they are to do. Now to return to Free Trade axioms, it is well understood that for all imports there must be exports, and *vice versâ*. Our imports seem at present to be increasing in undue ratio to exports. If we are unable to export other manufactures owing to hostile tariffs, we must export the agricultural labourer, who is the product of cheap imported food. This will be in consonance with our system of importing the raw material and exporting the manufactured article. He must be exported at the expense of the country, but as no one here will benefit appreciably by it, this can hardly be confounded with the bounty system which gives us such cheap sugar for making jam.

"Trader" writes a great deal about those who live on the proceeds of foreign securities, and the benefit they get from our system. But is not the benefit of the consumer the end and aim of Free Trade, and who has so clearly a right to the title as these; to hear some men talk, one would think they consider the producer deserving of the greater consideration.

"Trader" asks why it is right and proper to tax tea—a poor man's necessary—while it is wrong to tax silk, a rich man's luxury. This is really elementary; to tax silk would be possibly to restore one of our industries and reduce imports, and, therefore, altogether against Free Trade principles; but the revenue must be obtained, and we only tax those who get from foreign countries that which they are unable to obtain from their fellow countrymen.

It is asked if the Americans believe in our system. Certainly not, and a very lucky thing for us, for if they adopted Free Trade our commercial supremacy would be gone. For every export there must be an import of corresponding amount, and therefore America would be able, if she adopted Free Trade, to flood the world with her goods without taking anything herself; and as imports are income and exports expenditure, she would thus increase her expenditure to an unlimited extent without increasing her income.

If this does not make everything clear to "Trader," I am afraid I must give him up. I have not thought it all out myself, but have taken the opinions of the greatest experts, and shall be happy to give "Trader" chapter and verse if he is willing to take the free trade creed by authority. If not, I shall despair of his ever becoming an intelligent free trader. JOHN BRETT.

Park Lodge, Heath-road, Hounslow, December 7th.

THE DRAUGHTSMEN'S PROVIDENT SOCIETY.

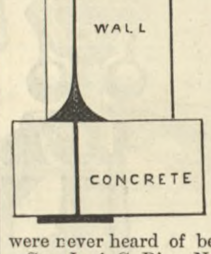
SIR,—I am desired by the committee which has been appointed to draw up the rules for the establishment of the above society, to ask permission to state in your columns that these are now nearly ready, the only thing required being the sanction of the Registrar of Friendly Societies. As they have been drafted upon the same lines as those of a society which is already registered, it is contemplated that there will be little delay, and it is hoped that the society may start upon a career of usefulness by the beginning of next year. Gentlemen who intend to join would much oblige by communicating with me at once, and I will send them a copy of the rules, together with the necessary forms of application as members. The first hundred members will be admitted without the payment of any entrance fee, but after that an entrance fee of 5s. will be charged to each. The tables upon which sickness allowance and life assurance will be granted have been decided upon as low a scale as is consistent with successful working. To secure an allowance of one guinea per week for the first thirteen weeks during illness, and of half this sum for a further period of thirteen weeks, a man aged twenty last birthday will have to pay 7s. 8d. a quarter; to insure £25 to his successors at death, he will have to pay 2s. 5d. a quarter until he reaches the age of sixty-five. Larger sums can be assured at sickness, and smaller at death, at similar rates. It is also in contemplation to form a loan fund, but the details of this have not yet been worked out. The committee are empowered under the rules to use 10 per cent. only of the premium receipts towards the expenses of management. This may not suffice during the few months, and therefore I should be glad to receive special subscriptions to meet the initial expenses from members of the profession who wish well to the movement.

G. A. T. MIDDLETON, A.R.I.B.A., M.S.A.,

St. James' Hall, Piccadilly, W., Dec. 2nd. Hon. Sec.

ON THE CONSTRUCTIVE IRONWORK IN A NEW THEATRE.

SIR,—Having carefully read the article in THE ENGINEER of September 23rd, as advocated by Mr. Max am Ende, I beg to suggest the following alteration. According to my idea, there is too much iron in the bed plate *a*, and the whole of the iron in front of the column C towards the pit could be done away with, leaving enough outside the column to give a good support to the base of the column, and instead of this iron, I would lengthen the anchorage bar B, so that it passes the foundation of the main walls and provides the anchorage bar with a heel on the top of the concrete, to support its own weight, as in sketch.



I think it rather an advantage that the ironwork should be connected to the wall, especially when, as in theatres, the structure is high; and now-a-days earthquakes are affecting countries which were never heard of before in regard to the earthquakes.

San José, C. Rica, November 6th. JOHN S. DE JONGH.

COMPARATIVE TENSILE STRENGTH OF ELECTROLYTIC AND ORDINARY COPPER.

SIR,—During the hearing of the recent trial of Elmore *v.* Pirrie, Messrs. Goodwin and How, civil engineers, of Westminster, who were engaged in the case, called my attention to a statement in my work, "Electro-deposition," which is incorrect and misleading, and I shall feel greatly obliged if you will permit me to correct that statement in the columns of your valuable paper. On page 144 of my book a comparison is drawn between the tensile strength of sheet copper as manufactured by the ordinary process, and copper deposited by the Hallett-Elmore dynamo, which would lead readers to believe that the latter material broke under a tensile strain equal to 32 tons per square inch of the original area, and at the same time elongated 38·3 per cent. Now, this statement, which was given to me by Mr. Elmore for publication, is incorrect. From several tests carried out by Messrs. Goodwin and How, to ascertain the comparative strength of electrolytic copper deposited very slowly and ordinary copper, it appears that the latter is the stronger of the two. I trust you will favour me by inserting this. ALEXANDER WATT.

November 8th.

SOME DEFECTS IN FURNACES COMMONLY TERMED DESTRUCTORS.

SIR,—The importance, from a sanitary point of view, of the principles involved in the destruction by burning of town "refuse" as soon as collected has apparently still to be fully recognised, if we may judge by the limited number of instances in which the process has been finally adopted on a comprehensive scale and otherwise than as a mere experiment. This may to some extent at least be due to the fact that but little information is available in a concise and readable form with respect to the experience obtained where furnaces have been introduced, and that what has been published is somewhat conflicting. As the subject is one of general public interest, I shall be glad should this induce some correspondent to supplement the recorded facts concerning the so-called "Destructor" by detailed particulars showing the cost of dealing with "refuse" before and after its introduction. Without pretending to exhaust the question, or to prove the utility and importance or otherwise of the "Destructor," I propose, with your permission, to submit for review some of the leading facts regarding it which experience has made prominent.

During a discussion at a comparatively recent meeting of the Association of Municipal and Sanitary Engineers and Surveyors on "Some Defects in Destructors," it was made tolerably clear that the direct result so far has been increased taxation to the ratepayer from its introduction, or, in other words, an increase has resulted in the cost of dealing with the refuse which it is designed to destroy, together with the creation of two distinct nuisances to residents in its immediate vicinity. If to these be added the fact that a "Destructor" seems to constitute a new source of worry and perplexity to the engineer or surveyor who is called on to devise means for the abatement of the alleged nuisances, the indictment against it becomes formidable, especially so when it is considered that the only argument in its favour is its probable value as a destroyer of matter which may contain germs of, or may germinate, disease. This, unfortunately, though admittedly an important consideration, is somewhat intangible when proof is sought. It is, in fact, practically impossible to express the value of the "Destructor" in a financial form, under this head, as a set-off against increased taxation consequent on its introduction.

Some few isolated cases might be adduced where the origin of a contagious disease has been believed to have been traced to the proximity or handling of town "refuse" at a distance from the original point of collection. These would be considered a sufficient reason by thorough-going sanitarians for the prompt destruction as soon as collected of all combustible "refuse" in which a possibility of danger to health existed.

This is no doubt the correct principle by which to be guided; but it must be admitted that the sceptic who requires and demands irrefragable proof of utility and importance, who sees in a proposal to construct furnaces for burning town "refuse" nothing but what he may term a sanitarian "fad," has some ground for argument against their introduction in the increased cost of dealing with the refuse and the nuisance of dust and noxious gases which they are alleged to cause. It may be taken for granted, however, that the question of increased cost is the principal reason against a more extended and general adoption of the "Destructor."

What appears to be necessary is that the cost of burning should be reduced; that a better form of furnace should be adopted; that the waste heat should be utilised to better purpose; that care should be taken in the selection of a site for furnaces, avoiding thickly populated neighbourhoods as far as practicable. With regard to the labour necessary for firing and stoking, there is probably but little actual saving to be accomplished without the introduction of automatic firing; even with it the saving would not be important, though more effective and increased combustion would result than has hitherto been obtained.

It has been the custom, by special instruction of the designers of the most popular furnace, to charge to full capacity, and permit the charge to smoulder—it could scarcely be said to burn—for about two hours without disturbance. The result, as might have been anticipated, has been irregularity of heat and consequent irregularity of steam pressure where the heat is utilised to generate steam in a boiler, besides causing the largest portion of the gases evolved to fly off unconsumed. A point of much importance which appears to have been entirely overlooked in the "Destructor" referred to, the only one known to me, is that two distinct operations are required to be performed; hence one, if not both, of the nuisances complained of, since they are undoubtedly caused by imperfect combustion and excessive draught in the chimney shaft. Evolving the gases from the matter to be dealt with ought to be, as far as practicable, a distinct operation, performed prior to the entry of the material into the actual combustion chamber, where the stoking and charging should be so regulated as to maintain the charge in a glowing, incandescent condition, capable of consuming all the gases evolved on their way to the shaft.

The necessity for consuming the gases evolved has already been recognised, and efficiently provided for, so far as the existing form of "Destructor" is concerned, by a "cremator" introduced by Mr. C. Jones, Assoc. Mem. Inst. C.E., at Ealing. The "cremator," however, is a supplementary furnace charged with coke, and must of necessity be an additional item of cost in firing, attendance, &c. The proximity of houses to the "Destructor" appears to be the main, possibly the only, reason why the alleged nuisances should be considered of much importance, as there is no suggestion of actual danger to health from them. Perhaps the most troublesome of the two evils complained of in the "Destructor" by residents in its immediate neighbourhood is the discharge of dust from the chimney shaft.

The reason for locating a set of furnaces in a thickly populated centre is obviously in the first instance to secure economy in haulage, but it may be questioned whether the advantage gained in this respect is important when a large percentage of slag and ashes have to be removed to a rubbish tip at a distance. Even if the alleged nuisances are more assumed than real, their mere suggestion is obstructive, and it does not seem desirable to prejudice the utility of a sanitary reform by carelessness in the location of its instruments.

Possibly the most suitable site for a "Destructor" is at sewage clarification works, as at Ealing, where the steam power can generally be utilised to better purpose than driving mortar mills. The demand for mortar is not always constant, and as the lime is mixed with the slag during the process of grinding, it cannot be stored long without deterioration. The utilisation of the slag or cinder produced by the "Destructor" as a material for concrete or asphalte pavement has already been suggested, and for this purpose it might be found of considerable value in some localities. Generally where an attempt is made to grind up the slag in mortar mills the heat obtainable is not sufficient to grind up the whole quantity produced; the surplus has, of course, to be removed to a tip.

The absolute ignoring of natural laws evinced induces astonishment, and suggests for the credit of the Association of Mechanical and Sanitary Engineers and Surveyors that individual vagaries and blunders should not be published in the reports of their meetings. However much a discussion of such blunders may benefit or amuse, the status of the association must suffer from their being made public. A.M.I.C.E.

Sheffield, November 21st.

FEATHERING PADDLE-WHEELS.

SIR,—I have delayed some time in sending an answer to Mr. Hartland's criticisms on the theory of the feathering paddle-wheel which I advanced, hoping that he would look into the subject again a little more closely, and that he would modify in consequence his first objections. Mr. Hartland's illustration of the operation of heaving the lead is very apt and striking, but applies only to the theory of the oar, as I attempted to explain in my letter. But when we come to the paddle-wheel this illustration fails us, as we have the lowest floats of the wheel moving past the sides of the vessel with a relative backward velocity equal to the velocity of the vessel through the water plus the slip velocity, while relatively to the water just in front of the wheel the floats are moving backward with the slip velocity. Consequently in order to enter the water edgeways without shock, the floats must have some such direction as that assigned in my letter—that is, the entering floats must be inclined slightly from the vertical position so as to be nearly parallel to the direction of the emerging floats; and according to the usual theory given in the books, the direction of the plane of an emerging float should pass through the highest point of the pitch circle of the paddle-wheel. I have not yet learned whether this theory has been applied practically, but I feel confident that time will reveal a great improvement on the ordinary method of construction of the paddle-wheel, where the entering float is made to take a direction passing through the highest point of the pitch circle, the same as the emerging float.

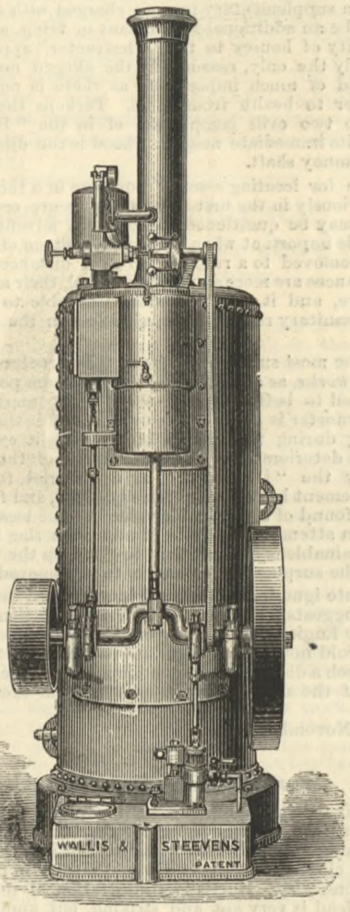
Woolwich, December 5th. A. G. GREENHILL.

THE MANCHESTER GEOLOGICAL SOCIETY.—At the meeting on Tuesday, a short description was given of an improvement in miners' safety lamps, which has been invented and just patented by Mr. Wm. Wood, of Manchester, the object of which is to provide a simple means of instantly extinguishing a lamp in the event of its being brought into the vicinity of explosive gas. This is effected by providing the lamp with an extinguisher or hood which is held over the flame and supported by a rod or float dipping into a column of mercury. This mercury becoming expanded by the extra heat imparted to the wire gauze when the lamp is in an explosive atmosphere, so raises the rod or float that the extinguisher is permitted to fall over the flame, and thus at once extinguish the lamp. This seems to be a very simple, and at the same time, effective arrangement which can be applied to all classes of lamps, and it is understood that a lamp fitted up with one of these extinguishers will be exhibited at the next meeting of the Society, when, no doubt, it will receive the attention of the members, who are mining engineers.

THE AGRICULTURAL ENGINEERS' ASSOCIATION.—On Wednesday evening the members of the Agricultural Engineers' Association and their friends took their annual dinner at the Holborn Restaurant, Mr. H. D. Marshall, the president, taking the chair. After the usual toasts, Mr. Marshall spoke at some length of the work of the Association during the past year, especially in connection with the reduction of the charges for space by the Royal Agricultural Society, the reduction of railway rates, concerning the rating of machinery and the rules and laws under which traction engines are worked in the United Kingdom. He also, with a good deal of apology, and as a matter much concerning agricultural and other British manufacturing engineers, spoke at some length on foreign tariffs, and gave a good many facts and some strong reasons in favour of import duties on all manufactured goods and materials from countries which imposed duties on the import of our manufactures. He avowed himself convinced, by his own large experience in foreign trade, of the importance of retaliatory duties—in fact, a sort of fair-trade policy appeared to him essential, and our fiscal policy urgently needed reconsideration.

THE SMITHFIELD CLUB SHOW.

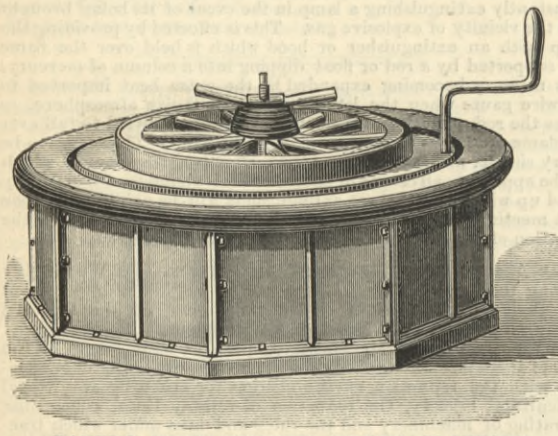
The visitors to the Smithfield Club Show at Islington, whose object is to see the cattle and sheep and pigs, are probably quite satisfied that all these are much the same in structure as those that were exhibited nearly a century ago. Certain small changes are from time to time, no doubt, made by the growers' selections for parental fitness, according as popular taste for more or less fat demands, just as that change of taste has now made the long razor-backed pig now the favourite for the supply of bacon; but, generally, the expectation that something will be exhibited that is worth going to see must be founded on some other ground than a hope of finding any striking novelty. Fine forms, evidence of breeding, and good coats, perhaps constitute the outcome of the art of the stockbreeder which attracts the public to that part of the show. We hope that engineers and machinists will learn to visit the annual collection at Islington with similarly modest expectations of novelty, and that they will be able ere long to subdue that restless craving for the sensational in mechanical newness which seems unfortunately to characterise that half of the world which lives in great cities. To its continual discontent, however, that half the world is burdened with



WALLIS AND STEEVENS' COMPOUND VERTICAL ENGINE.

the knowledge that manufacturing trade very much depends upon being able to offer something that in one way or another, is, or appears to be, better than that offered by our competitors across the seas. This makes it anxious and ever on the look out for the latest thing or for a hint as to what is likely to be a profitable line of mechanical scheming. Few people can visit the Islington show entirely without profit if they have observational faculty, but striking novelties are as usual not plentiful. They will see more good work than ever, they will not see many new names, and they will miss a few old names. The Reading Ironworks Company, which succeeded to the business of Messrs. Barrett, Exall and Andrews, and was too considerate to offend old memories by new designs and ideas, has ceased to appear, and its corner is appropriated as an addition by two of the firms that are awake.

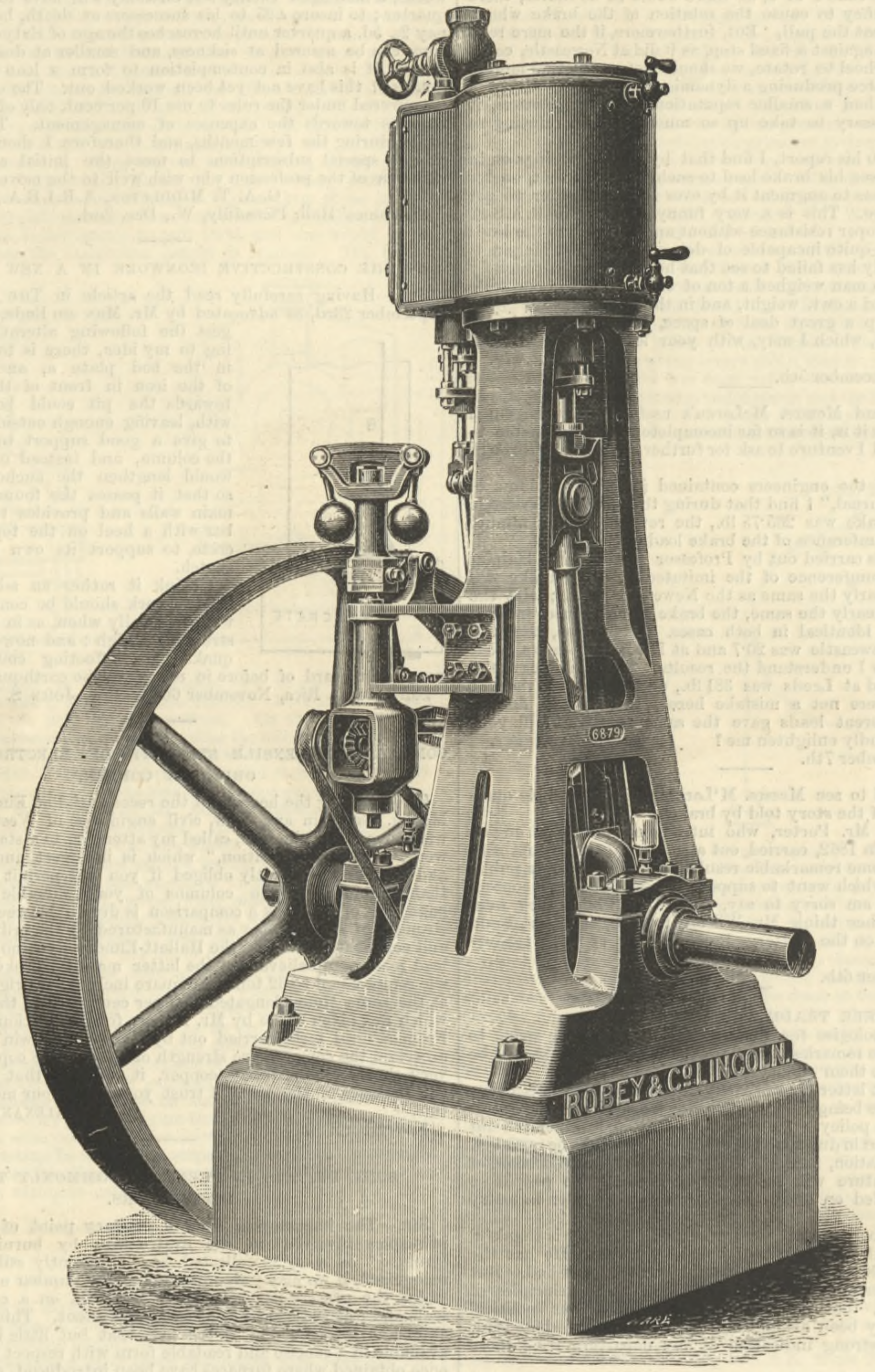
The visitors will find plenty of good things, and a few that they will look at twice. On entering the show they will find on their left what Messrs. John Fowler and Co. call a six-horse compound traction engine. To look at this engine one would think that horses must be growing


BAKER'S WHEELWRIGHTS' SINKING PLATFORM.

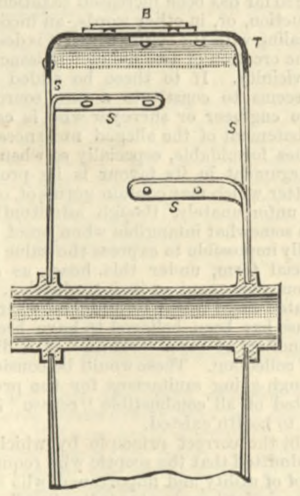
larger than in the days of Watt, and that engines had been forced to do the same. On the same makers' stand is a horizontal fixed engine that, without any objectionable features, looks as though it were intended to be called the unbreakable or the everlasting. It has a cylinder 9in. diameter and the stroke is 12in., and the crank of this engine is nearly 5in. in diameter. Messrs. Fowler and Co. evidently have no wish to stint material, but their mode of calculating the size of a crank shaft would appear to be one which dispenses with pencil, paper, and formulæ. The engine will, however, find many admirers, and purchasers will no doubt like it for driving dynamos.

Messrs. Clayton, Shuttleworth and Co., on the next stand, show a new pattern compound horizontal engine, which also appears to be made with a Brobdignag notion of a horse-power. This engine has a high-pressure cylinder 6·75in. diameter, and a low-pressure cylinder 11·625in. diameter, their stroke being one foot. It is fitted with an automatic cut-off gear, actuated by a powerful cross-armed governor, and is a well-designed, splendidly-finished engine. The makers call it a 10-horse power nominal. We believe that no one will be severely punished if they call it something more, for the engine might very well run at 160 revolutions per minute and 140 lb. steam. The engine is very cheap at the price, but we do not know what the price is; within reason it does not matter what the price is. It has several noteworthy features, and we hope to illustrate it in an early impression. On the same stand is the 22,222nd thrashing-machine made by this firm; it has some small but useful improvements, including a movable chaff-spout, by which when the chaff is not bagged it may be either mixed with the cavings or directed into another place. Messrs. Clayton do not charge for all the improvements they make in their thrashing-machines; and, judging by the above number, the policy seems to pay.

Messrs. C. Burrell and Sons exhibit a traction engine mounted on springs, the main axle being attached close behind the fire-box, and the load carried by means of spiral springs. To allow for the movement of the main driving axle, the second motion shaft receives motion from the wheel, into which the crank shaft pinion gears by means of a universal joint. This motion it transmits, at its other end, to the road wheels by gear which rises and falls with the main axle. The brake is applied to the wheel on the second motion shaft.

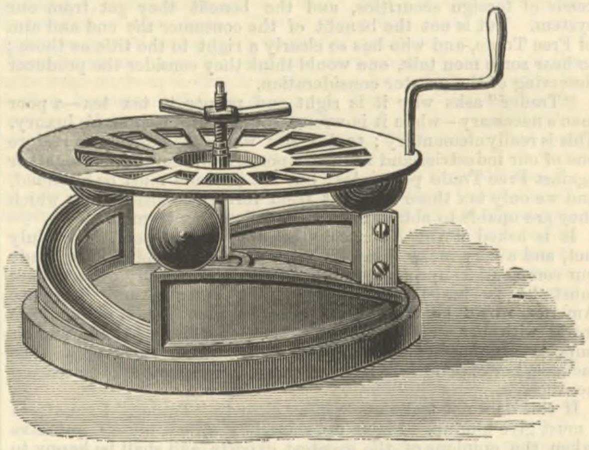


ROBEY AND COMPANY'S VERTICAL ENGINE.



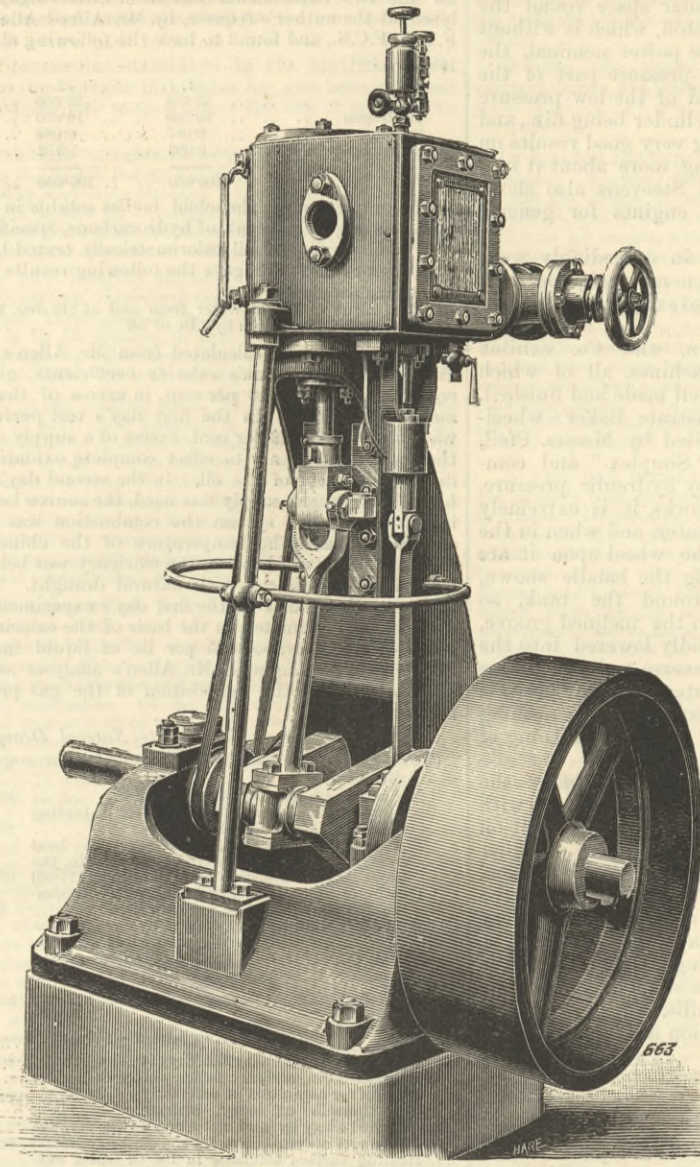
HOWARD'S REAPER WHEEL.

Messrs. Ransomes, Sims, and Jefferies, show a new design of 4-horse power portable engine and new horizontal engine of self-contained type, an excellent engine suitable for electric lighting work, or any requiring good driving. Messrs. J. and F. Howard show an excellent new light strong wheel made primarily for reaping machines. It is made with a light steel rim and steel spokes cast with a long boss, as shown by the accompanying sketch of half section. The

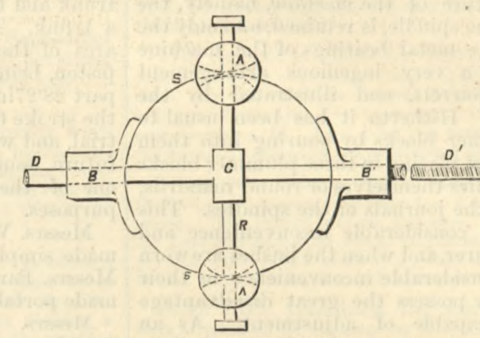

BAKER'S SINKING PLATFORM.

tire or rim is made from a long wide strip of steel ⅛in. thick, and this is bent and turned inwards at both edges, as shown in the section at T. The spokes are cast into the boss and are rivetted to the rim by rivets, which also hold the strips or roughing-pieces B. This makes a strong and, at the same time, a light, wide wheel as required for sheaf-binder reapers.

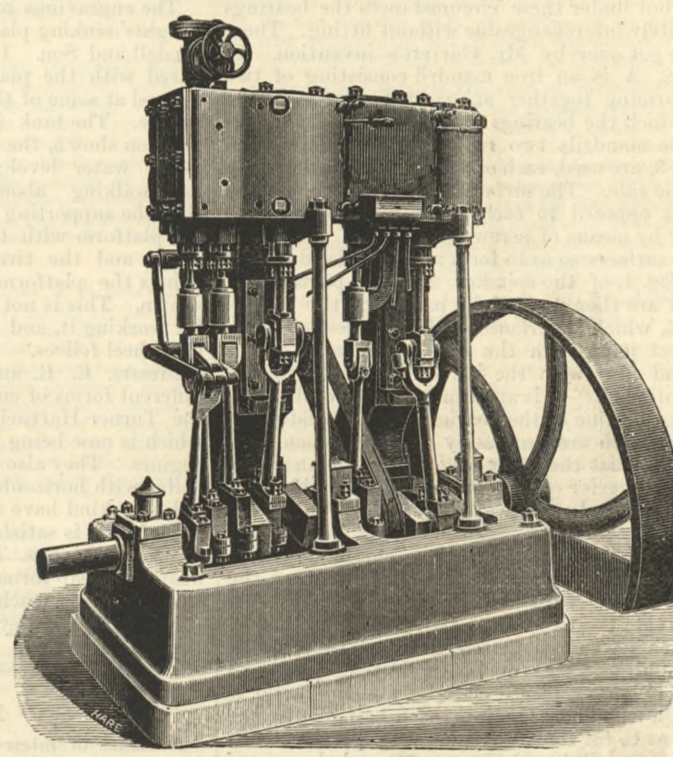
EXHIBITS AT THE SMITHFIELD CLUB SHOW.



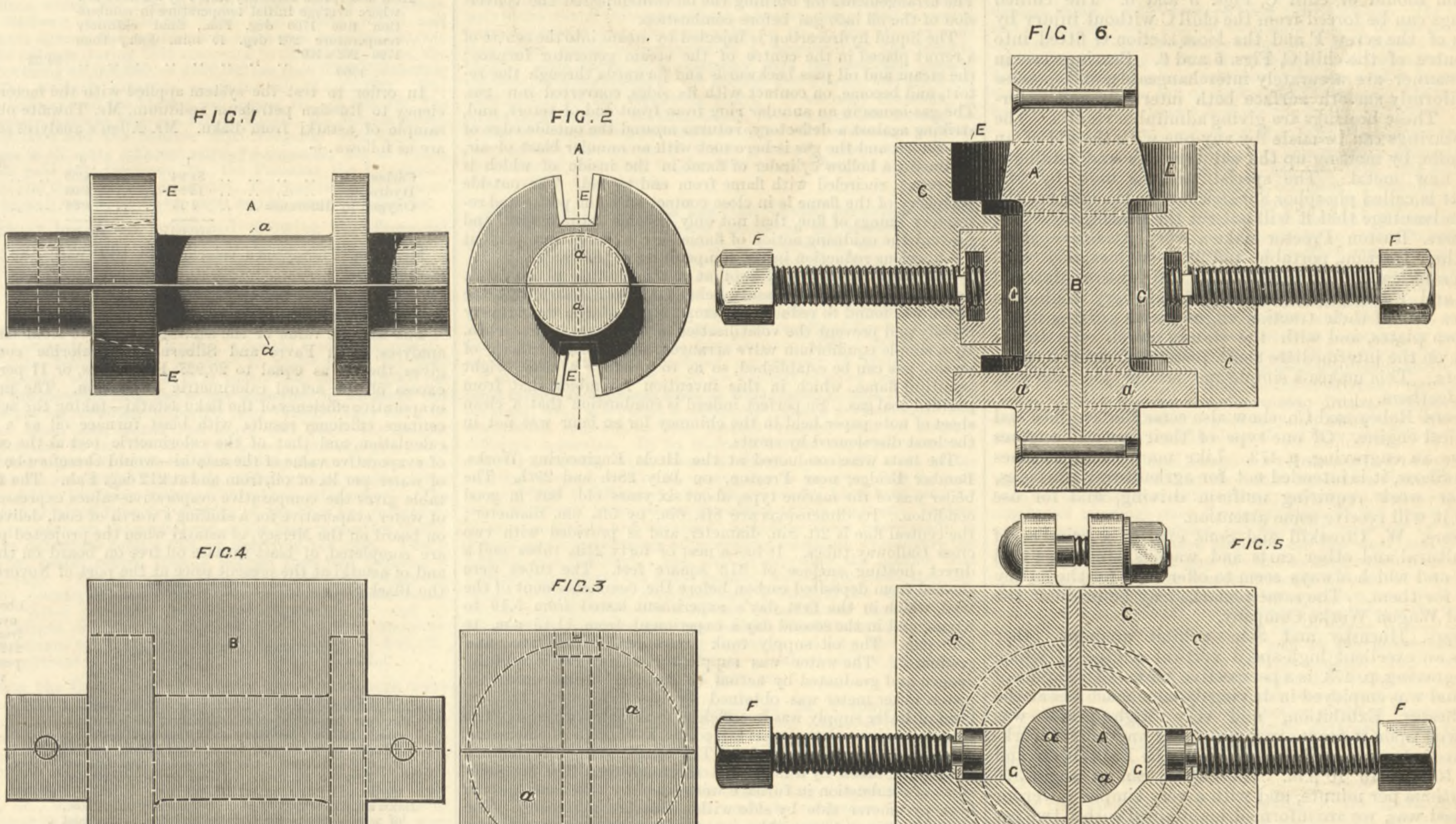
HORNSBY'S HIGH-SPEED VERTICAL ENGINE.



GOVERNOR OF HORNSBY'S ENGINE.



DAVEY, PAXMAN, AND CO.'S HIGH-SPEED COMPOUND VERTICAL ENGINE.



GARRETT'S CHILLED MOULDS FOR CASTING BEARINGS.

Mr. F. Savage shows the Darby steam digger in its latest form. This is a machine which has been very successfully and economically at work for some time, and has been materially improved since the Royal Agricultural Society awarded it the first prize at Carlisle as the best steam cultivator.

Messrs. Davey, Paxman, and Co. exhibit one of the simple portable engines with which they carried off the £100 prize at Newcastle last July, and they exhibit their new vertical boiler in such a way as to show the arrangement of the tubes and the facility with which they may be drawn or put in place. This boiler is illustrated on another page. The small V-shaped combustion and smoke chambers are made of mild steel and stamped out of one piece; they afford a remarkable illustration of what may be done with good mild steel. The same firm exhibits a horizontal and a vertical high-speed compound engine. Of the latter the above is an illustration, which serves to show its type. The cylinders of the engine exhibited are 4·75in. and 7·5in., and the stroke 7in., and is nominally 6-horse power. It is a well-made engine, and is fitted with Paxman's automatic cut-off.

Messrs. Richard Garrett and Sons exhibit with simple and compound engines, one of their thrashing machines in which some improvements have been made which enable the user to deliver the chaff in a better position than heretofore, namely, under the centre of the machine, and this is done in such a manner that a large screen at the side of the machine permits the escape of the dust from the chaff as it is passing to the central down delivery. The distinguishing feature of the machine, namely, the powerful fan on the drum spindle, is retained, and only the one fan used. The white metal bearings of the machine are cast on chills by a very ingenious arrangement patented by Mr. F. Garrett, and illustrated by the engravings on page 473. Hitherto it has been usual to bush bearings for plummer blocks by pouring into them molten Babbit metal, first placing in these plummer blocks the journals of the spindles themselves or round mandrils, which are facsimiles of the journals of the spindles. This process is attended with considerable inconvenience and expense to the manufacturer, and when the bushes are worn there has been found considerable inconvenience in their replacement, whilst they possess the great disadvantage of being generally incapable of adjustment. As an alternative to bushes, bearings made of white metal alloys in separate halves have been cast around mandrils laid in sand moulds, but under these circumstances the bearings are not accurately interchangeable without fitting. These objections are got over by Mr. Garrett's invention. In Figs. 1 and 2, A is an iron mandril consisting of two halves, *a a*, forming together an exact facsimile of the journals for which the bearings are required. In manufacturing these mandrils two rectangular or half-round bars *a a*, Fig. 3, are used, each of which is first accurately surfaced on one side. The surfaced sides or faces of these bars are then opposed to each other, and the bars are fixed together by means of screws or pins and turned on their exterior surfaces so as to form an exact facsimile of the journal, Fig. 1, of the spindle. The two parts *a a* of the mandril A are then divided by means of the winged plate B, Fig. 4, which is surfaced on both sides so as to make a perfect joint with the two halves *a a* of the mandril A and also with the halves *c c* of the chill C hereafter mentioned. C is an iron mould or chill forming the exterior outline of the bearings, and consisting of two halves *c c*, which are accurately surfaced when they come together, so that they may together form an exact facsimile of the interior outline of the plummer block or bracket for which the bearings are required. When casting the interchangeable bearings under this process the iron mandril A is placed within the iron mould or chill C, Figs. 5 and 6, in such a manner that the wings of the plate B, which separates the two halves *a a* of the mandril A, may also divide the two halves *c c* of the iron mould or chill C, which are then bolted or cramped together as usual with moulding flasks or boxes, Fig. 5. The iron mould or chill C is then placed endwise, and the metal is poured through the holes E E in each half *a a* of the mandril A, so as to fill the cavity existing between each half *a a* of the mandril A and the respective halves *c c* of the iron mould or chill C, Figs. 5 and 6. The chilled bearings can be forced from the chill C without injury by means of the screw F and the loose section G fitted into the centre of the chill C, Figs. 5 and 6. Bearings cast in this manner are accurately interchangeable, and possess an uniformly smooth surface both internally and externally. These bearings are giving admirable results. The new bearings can be made by any one with the aid of an iron ladle, by melting up the old bearings and adding a little new metal. The special mixture used by Mr. Garrett is called phosphor anti-friction metal, and has the great advantage that it will not cut the bearings.

Messrs. Ruston Proctor make a very attractive show with their traction, portable, and fixed engines, and with their crankless thrashing machine; and Messrs. Marshall Sons and Co., exhibit amongst other very high-class engines one of their traction engines with gearing inside the horn plates, and with the sliding pinion on a larger square on the intermediate shaft instead of upon keys or feathers. This makes a simple and strong job, and gets rid of feathers.

Messrs. Robey and Co. show also some fine engines and a vertical engine. Of one type of their vertical engines we give an engraving, p. 473. Like many other engines in the Show, it is intended not for agricultural purposes, but for work requiring uniform driving, and for use where it will receive some attention.

Messrs. W. Crosskill and Sons exhibit a number of agricultural and other carts and wagons which are well made, and which always seem to offer a lot for the money asked for them. The same remarks may be made of the Bristol Wagon Works Company.

Messrs. Hornsby and Sons exhibit amongst other things an excellent high-speed vertical engine of which the engraving, p. 473, is a perspective view. An engine of this kind was employed in driving dynamo machines at the Manchester Exhibition, and very high praise was bestowed upon it for its very quiet and uneventful working throughout the whole period of the Exhibition and from 10 a.m. to 10 p.m. The engine ran at about 370 revolutions per minute, and with a very simple governor its speed was, we are informed, maintained within two per cent., and adjustable as to speed by that amount. The engine exhibited has a cylinder 7in. in diameter and a stroke of 9in., and it is made to run at 400 revolutions per minute. It is called a 12-horse power nominal, but at the speed mentioned and a mean pressure of 50 lb. per square inch it will be seen that the indicated power would be about three times this. A feature in the engine is the great care taken in balancing it. It has a steel crankshaft, with a crank and large balancing masses all forged in one piece and slotted out, and no doubt much of the success of the engine at the high speed adopted is due to the care in balancing the whole of the parts. The governor is shown by the accompanying sketch, in which balls A A are carried by a spring S S attached to the bosses B and B[1], the boss B being fixed upon the spindle D, and the boss B[1] sliding upon it, so that as the balls fly outwards by centrifugal action, that boss permits the spring to change its form. The spindle at D[1] is screwed, and a spiral spring is put upon the spindle between the bearing and B[1], so as to adjust the governor.

Messrs. Wallis and Steevens show a new small compound vertical engine, of which a general view is given in the engraving, p. 472. It is of the trunk-engine type, the steam being admitted to the annular space round the trunk and then to the top of the piston, which is without a trunk. The engine is of 2-horse power nominal, the area of the annular part, or high-pressure part of the piston, being 9·6 square inches, and of the low-pressure part 28·27in., the diameter of the cylinder being 6in., and the stroke 6in. The engine is giving very good results on trial, and we expect to say something more about it in a future issue. Messrs. Wallis and Steevens also show one of their well-known traction engines for general purposes.

Messrs. W. Foster and Co. show an exceedingly well-made simple portable engine for general work, and with Messrs. Barrows and Stewart are also exhibitors of a well-made portable engine.

Messrs. Farmer, Robey, Brown, and Co. exhibit portable engines and thrashing machines, all of which are of good and recent design and well made and finished.

The engravings on page 472 illustrate Baker's wheelwrights' sinking platform, as exhibited by Messrs. Pfeil, Stedall and Son. It is called the "Simplex" and compared with the platforms raised by hydraulic pressure, as used at some of the best wheel works, it is extremely simple. The tank is filled with water, and when in the position shown, the platform and the wheel upon it are above water level; but by pulling the handle shown, and walking about two-thirds round the tank, so that the supporting balls enter upon the inclined groove, the platform with the wheel is rapidly lowered into the water and the tire cooled. A reverse pull of course brings the platform out of the water into the position shown. This is not an expensive tool, and costs nothing for working it, and saves time and prevents burning of the wheel felloes.

Messrs. E. R. and F. Turner exhibit several of the different forms of engines made by them and fitted with the Turner-Hartnell governor, and automatic cut-off which is now being largely used by the makers of other engines. They also exhibit an economical form of vertical boiler with horizontal tubes, and as vertical boilers of the ordinary kind have acquired so bad a name as being very wasteful, it is satisfactory to see that boilers of the type shown by Messrs. Turner are taking the place of the wasteful cheap forms. On the same stand are numerous food-preparing machines and corn mills.

Mr. E. S. Hindley shows a collection of his useful little engines.

LIQUID FUEL.

A SERIES of interesting experiments with liquid fuel has recently been carried out by Mr. B. H. Thwaite, of Liverpool. The arrangements for burning the oil contemplated the conversion of the oil into gas before combustion.

The liquid hydrocarbon is injected by steam into the centre of a retort placed in the centre of the steam generator furnace; the steam and oil pass backwards and forwards through the retort, and become, on contact with its sides, converted into gas. The gas issues in an annular ring from front end of retort, and, striking against a deflectory, returns around the outside edge of the retort, and the gas is here met with an annular blast of air, producing a hollow cylinder of flame in the inside of which is the retort, encircled with flame from end to end. The outside periphery of the flame is in close contact with the perforated refractory linings of flue, that not only become incandescent and prevent the oxidising action of flame on the plates, but prevent a too serious reduction in the temperature of the flame.

The steam is preferably kept at a temperature above 50 lb. per square inch; at a pressure below 30 lb. per square inch the steam was found to reduce the temperature of the retort very rapidly and prevent the volatilisation of the liquid hydrocarbon. By a simple equilibrium valve arrangement, an exact balance of air and gas can be established, so as to produce a clear bright beautiful flame, which in this invention resembles that from purified coal gas. So perfect indeed is combustion that a clean sheet of note paper held in the chimney for an hour was not in the least discoloured by smuts.

The tests were conducted at the Hecla Engineering Works, Bamber Bridge, near Preston, on July 28th and 29th. The boiler was of the marine type, about six years old, but in good condition. Its dimensions are 8ft. 6in. by 5ft. 6in. diameter; the central flue is 2ft. 8in. diameter, and is provided with two cross Galloway tubes. It has a nest of forty 2¼in. tubes and a direct heating surface of 313 square feet. The tubes were cleaned from deposited carbon before the commencement of the trial, which in the first day's experiment lasted from 5.10 to 8 p.m., and in the second day's experiment from 11.15 a.m. to 2.30 p.m. The oil supply tank was carefully calibrated and graduated. The water was supplied from two casks carefully gauged and graduated by actual volumetrical measurement; a piston water meter was obtained for the experiment, but the head of water supply was insufficient to actuate the piston. The volume of air used was ascertained by a Biram's anemometer, corrected by Davis, of Derby. The temperatures of chimney gases were taken by a mercurial thermometer. The temperatures of combustion in furnace were taken by a Siemens' specific heat pyrometer side by side with a Murrie's pyrometer. The latter instrument resembles an ordinary mercurial barometer, with the lower end coupled to a pressure indicator. The mercury volatilises at its upper end on being immersed in the furnace, the pressure of the vapour being transmitted through the intermediate fluid to the indicator, which is graduated to show the corresponding temperature. This instrument is admirably adapted for its purpose, and its readings correspond sufficiently near to those given by the Siemens' pyrometer. The chimney gases and those generated by the retort were aspirated into two gas-collecting vessels, but owing to defects of stopper corks—due to transit—it was not considered useful to proceed with the analysis of the contained gases.

Throughout both experiments there was, with the exception of a few minutes, a perfect immunity from smoke, the exception being simply light-coloured vapour. After the trial the tubes were examined, and found quite free from deposited carbon. In preliminary experiments it was noticed that when the retort was cold the flame produced was very smoky, but as soon as the temperature of the retort attained the degree necessary for the volatilisation of the oil, the flame became quite clear and beautiful. The steam was quite dry, and drove all the machinery in the fitting shop. The pressure varied from 55 lb. to 75 lb. In the first day's experiment the air for combustion was supplied by natural draught; the arrangement of air receiver enabled an equable and heated supply of air to be obtained. The oil used for the two experiments was from Coatbridge, Scotland, analysed, at the author's request, by Mr. Alfred Allen, of Sheffield, F.I.C., F.C.S., and found to have the following elementary composition:—

	1.	2.	Average.
Carbon	83·380	83·900	83·640
Hydrogen	10·530	10·650	10·590
Sulphur	0·087	0·088	0·0875
Oxyg. by difference	6·003	5·872	5·9385
	100·000	100·000	100·2560

The proportion of phenoloid bodies soluble in alkali 16·5 per cent., leaving 83 per cent. of hydrocarbons, specific gravity 0·92. The same quality of oil calorimetrically tested by Mr. William Thompson, F.R.S. Ed., gave the following results:—

Fahrenheit units of heat	16,080
Equivalent to lbs. of water from and at 212 deg. Fahr. converted into steam by 1 lb. of oil	16·66

The thermic value calculated from Mr. Allen's analyses, with Favre and Silbermann's calorific coefficients, gives the oil as equal to 18,411, or 16 per cent. in excess of ths actual calorimetric estimation. In the first day's test perfect combustion was effected with 22 per cent. excess of a supply of air over that theoretically necessary to effect complete oxidation of the oxidisable elements of the oil. In the second day's experiment a forced air draught supply was used, the source being a Körting's injector. By this system the combustion was more localised and intense, and the temperature of the chimney was rather higher, and, as will be seen, the efficiency was below that of the first day's experiment with natural draught. The efficiency, shown by the results of the first day's experiment with natural draught, and estimated on the basis of the calorimetric value of 16·66 of water evaporated per lb. of liquid fuel from and at 212 deg. Fah., along with Mr. Allen's analyses as a synthetical basis to arrive at the composition of the gas produced, was as follows:—

First Day's Experiment—Natural Draught.

[NOTE.—Figures in brackets refer to lbs. of water evaporated from and at 212 deg. Fah.]

Net actual evaporative efficiency (14·97)	89 87	per cent.
Net useful evaporative efficiency after deducting steam for aspirating oil (14·33)	85·99	,,
Net thermic efficiency, including the heat carried away by, and necessary to elevate, the products of combustion up the chimney (15·90)	95·42	,,
Heating surface efficiency in lbs. of water evaporated per square foot per hour	2·392	
Heat absorption efficiency tested by Carnot's law where average initial temperature of combustion flue 1720 deg. Fah., and average final chimney temperature 248 deg. Fah., then $\frac{1720 - 248 \times 100}{1728}$	85·57	,,

Second Day's Experiment—Forced Draught.

Net actual evaporated efficiency (14·21)	85·25	per cent.
Net useful evaporative efficiency after deducting steam for aspiration of oil (13·58)	81·50	,,
Net thermic efficiency, including the heat carried away by, and necessary to elevate, the products of combustion up the chimney (15·42)	92·3	
Heating surface efficiency in lbs. of water evaporated per square foot per hour	1·936	
Heat absorption efficiency tested by Carnot's law where average initial temperature in combustion flue 1700 deg. Fah., final chimney temperature 262 deg. 40 min. Fah., then $\frac{1700 - 262 \times 100}{1700}$	84 53	,,

In order to test the system applied with the factors of efficiency to Russian petroleum residuum, Mr. Thwaite obtained a sample of astatki from Baku. Mr. Allen's analyses of this oil are as follows.—

	1.	2.	Average.
Carbon	84·94	84·59	84·94
Hydrogen	13·91	14·05	13·96
Oxygen by difference	1·15	1·36	1·255
	100·00	100·00	100·155

Mr. Wm. Thompson's calorimetric test with the same oil gave—

18,6112 British thermal units.	
Equivalent to lbs. of water from and at 212 deg. Fah. converted into steam by 1 lb. of the oil	19·28

The thermic value of the astatki, calculated from Mr. Allen's analyses, with Favre and Silbermann's calorific coefficients, gives the oil as equal to 20,927 Fah. units, or 11 per cent. in excess of the actual calorimetric estimation. The net useful evaporative efficiency of the Baku astatki—taking the actual percentage efficiency results with blast furnace oil as a basis of calculation, and that of the calorimetric test as the coefficient of evaporative value of the astatki—would therefore be 16·58 lb. of water per lb. of oil, from and at 212 deg. Fah. The following table gives the comparative evaporative values expressed in lbs. of water evaporative for a shilling's worth of coal, delivered free on board on the Mersey, of astatki when the projected pipe lines are completed, of blast furnace oil free on board on the Clyde, and of astatki at the present price at the port of Novorossisk on the Black Sea:—

Description and price of fuel.	Lbs. of water evaporated from and at 212 deg. Fah. per shilling's worth of fuel.
Coal at 12s. 6d., cost of loading 1s. 6d., firemen at 1s. per ton—total 15s., containing 90 per cent. combustible. Tested by calorimeter, evaporated 8·14 lb. of water per lb. of fuel (from and at 212 deg.), delivered free on board on the Mersey	1215
Blast furnace oil, delivered free on board on the Clyde, of 0·92 sp. gr., at 25s. per ton	1258
Baku astatki if delivered on the Mersey at £1 10s., of which 19s. is for freight, and 11s. is the cost of oil at Batoum	1238
Baku astatki delivered free on board at Batoum at 10s. 11d. per ton	3390
Kuban crude oil at Novorossisk at 24s. per ton	1547

LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—The usual monthly meeting of this Association was held on Saturday, the 3rd inst., at the Cannon-street Hotel. After the private business of the Association was concluded, Mr. Hitt gave a description of his new (*sic*) method of propelling ships by a combination of sail and paddle, and exhibited models of ships with his apparatus attached. The leading features of this invention consist in making the hull of the ship with a water passage up the centre, somewhat similar to the twin steamers which have been used at different times with a large paddle-wheel in the centre. Instead of the usual paddle-wheel driven by steam engines Mr. Hitt introduces a large wheel constructed with arms or vanes somewhat similar to those of a windmill. The whole surface of this wheel above the deck is exposed to the action of the wind, which causes it to revolve, and the ends of the vanes which go down into the wheel race lay hold of the water and propel the ship forward, at least Mr. Hitt says they do. After this a paper was read by Mr. W. T. Coates on "Heat and Work."

RAILWAY MATTERS.

IT is stated that the Glasgow Locomotive Works Company—Messrs. Dubs and Co.—has entered into an agreement to build in Canada the locomotives required for the Canadian Pacific Railway.

THE large locomotive exhibited by the Midland Railway Company at the Saltaire Exhibition has just been returned to Derby, and on 3rd inst. made a run at the rate of seventy-two miles an hour.

RAILWAY orders in wheels and springs have recently been placed here from the South Indian Railway Company, the Southern Mahratta Company, and other railways. Local companies have also placed some good orders for carriages for North-Western lines. The Cheshire Lines Committee are stated to be among the companies recently calling for supplies of rolling stock.

RUSSIA has two lengthy tunnels in hand. One is the Suram on the loop-line between Baku and Batoum, and will be nearly two and three-quarter miles long, and cost about £1,000,000; it is to be finished in 1890. The other is the eight mile tunnel through the Caucasus ridge on the railway leading from the north to Tiflis; the later is not yet fairly started.

AN English paper having said, "If American companies were compelled to keep their accounts in the mode prescribed by the Board of Trade here, it would do something to enlighten the ordinary investors, if not serve as a brake on actual extravagance;" the *Railroad Gazette* retorts, "If the Board of Trade prescribed the return of the ton and passenger mileage on English roads, items voluntarily given here, it would do something to enlighten British freighters, if not entirely break up the exorbitant freight charges, which possibly have a greater influence on the present industrial depression of that country than any other."

OF the 209 axles which failed on our railways during the first nine months of this year, 119 were engine axles, viz., 106 crank or driving, and 13 leading or trailing; 19 were tender axles, 2 were carriage axles, 66 were wagon axles, and 3 were salt van axles; 41 wagons, including the salt vans, belonged to owners other than the railway companies. Of the 106 crank or driving axles, 64 were made of iron and 42 of steel. The average mileage of 63 crank or driving axles made of iron was 211,147 miles, and of 42 crank or driving axles made of steel 218,299 miles. Of the 182 rails which broke, 74 were double-headed, 107 were single-headed, and 1 was of the bridge pattern; of the double-headed rails, 39 had been turned; 25 were made of iron and 157 of steel.

SPEAKING of the new Russian bridge over the Oxus a writer in the *St. James's Gazette* says:—"Until the other day no bridge had spanned the Oxus since the time of Timur the Tartar. On the 19th of October General Annenkoff rode across the new railway bridge, which is near enough to completion to allow of the passage of a man on horseback. Timur's bridge was a bridge of boats, and is described by the honourable knight, Ruy Gonzales de Clavijo, who was sent by the King of Castille on an embassy to the city which Milton knew of as 'Samarcand by Oxus, Temir's throne.' That was nearly five centuries ago. Moscow, which, as Gibbon says, once trembled at the approach of the Tartar, is already master of Samarcand; and the construction of the Russian railway bridge over the Oxus at Charjie is only the prelude to a formal annexation of Bokhara."

SOME interesting information has been published by the statistical department of the Russian Ministry of Ways and Means on the subject of Russian railways. On the 1st January, 1887, there was a total of 16,249 miles of railway, exclusive of the Finnish lines, which are 748½ miles in length, and of the Trans-Caspian Railway, which is 661 miles long. Using round and approximate figures, the capital sunk amounted to £248,000,000. The traffic mileage during 1886 amounted to 68,659,030½ miles, the net income being £9,000,000, or £600,000 less than for the preceding year. The working expenses amounted to £14,600,000. The Nicholas Railway had the highest net income, viz., £1,200,000; the South-western Railway followed with £700,000; the Moscow Kursk with £540,000; and the Moscow Nijni-Novgorod with £520,000. There were in all sixty different railway companies, out of which only three paid any dividends, viz., the Polisskia, the Ivangorod-Dombrovo and the Borovetschi railways. The apparent great success of the Nicholaij line is, however, explained by recent disclosures.

A REPORT has been published showing the financial position and the working of the railways in the Colony of Victoria. The total expenditure of the railways in Victoria charged against fourteen different loans, issued during the twenty-eight years since the first modest sum of £130,000 was borrowed, is £26,171,000. For this expenditure the colony has 1880 miles open for traffic, representing an average cost per mile of £13,920. Of this mileage only about one-seventh, or 245 miles, is double track, the remaining 1540 miles being single. Reduced to single track, the 2030 miles of railway was constructed at rather less than £13,000 per mile. If the colonists have had to pay somewhat in excess of our home charges for materials imported into Victoria, they have, on the other hand, been spared the heavy cost which the mother country has had to pay for land purchases, legal charges, and a host of other expenses, which have swelled up the cost of our railway system to over £42,000 per mile. The financial results of the working of the Victorian railways have been satisfactory. The net revenue obtained from the working of the lines has sufficed to pay 4·15 per cent. on the capital cost of the lines opened for traffic, and on the debenture capital 4·64, or nearly 4¾ per cent. This is a somewhat better return than is derived from the working of home railways. The Victorian lines afford the best illustration which any country offers of the results of working State-owned railways. After providing for all working expenses, and all interest charges on the £26,000,000 capital expended, there remained a balance to the credit of the public revenue of £40,457; this after payment of 4¼ per cent. on the capital expended.

DURING the first nine months of this year there were 296 servants of companies or contractors reported as having been killed and 1417 injured by accidents caused by the travelling of trains or the movement of vehicles used exclusively upon our railways. Of these 23 were killed and 173 injured whilst coupling or uncoupling vehicles; 3 were killed and 24 injured by coming in contact, whilst riding on vehicles during shunting, with other vehicles, &c., standing on adjacent lines; 9 were injured whilst passing over or standing upon buffers during shunting; 11 were killed and 89 injured in getting on or off, or by falling off, engines, wagons, &c., during shunting; 4 were killed and 86 injured whilst breaking, spragging, or chocking wheels; 9 were killed and 56 injured whilst attending to ground points, marshalling trains, &c.; 6 were killed and 133 injured whilst moving vehicles by capstans, turntables, props, &c., during shunting; and 23 were killed and 246 injured by various other accidents during shunting operations; 16 were killed and 55 injured by falling off engines, &c., during the travelling of trains; 5 were killed and 15 injured by coming in contact with over-bridges or erections on the sides of the line during the travelling of trains; 11 were killed and 80 injured whilst getting on or off engines, vans, &c., during the travelling of trains; 5 were killed and 113 injured whilst attending to, or by the failure of, machinery, &c., of engines in steam; 79 were killed and 76 injured whilst working on the permanent way, sidings, &c.; 2 were injured whilst attending to level crossing gates; 60 were killed and 99 injured whilst walking, crossing, or standing on the line on duty; 7 were killed and 45 injured by being caught between vehicles; 4 were killed and 29 injured by falling or being caught between trains and platforms, walls, &c.; 25 were killed and 26 injured whilst walking, &c., on the line on the way home or to work; and 5 were killed and 61 were injured from various other causes.

NOTES AND MEMORANDA.

DURING the first nine weeks of the current quarter the death-rate of London averaged 19·8 per 1000, and was 0·5 below the mean rate in the corresponding periods of the ten years 1877-1886.

DURING the nine months ending 30th September eighteen horses, two ponies, forty-eight beasts and cows, 104 sheep, seven donkeys, one goat, and one pig were run over and killed on our railways.

IN London last week 2599 births and 1704 deaths were registered. Allowing for increase of population, the births were 144 and the deaths 46 below the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes, which had been 19·4, 20·3, and 23·0 in the preceding three weeks, declined last week to 21·1.

IN the *Zeitschrift fur Analyt. Chemie*, Herr Beekman describes a very neat and rapid method for dividing glass tubes which are too large or too thick to break with a mere file nick. He scratches round with a file at the line where the division is required, then wraps round the tube on each side of the mark a strip of wet filter paper, and applies a Bunsen burner, or better, a blow-pipe flame. The method is equally good for the thickest glass tubes and the thinnest beakers. The space between the strips of filter paper should not be more than one to two millimetres.

A NEW and rapid method of soldering telegraph wires has recently been introduced and is now to be generally adopted in Russia. Its principal advantage consists in the saving of time required for the work, and in the avoidance of any "scraping," which would to some extent reduce the strength of the wire. The two ends of the wire—already embraced by binding wire—are dipped into a vessel holding a considerable quantity of melted solder, upon the top of which there is sufficient powdered sal ammoniac to leave a thick layer of liquid salt. The *Engineering and Mining Journal* says the ends of the wire pressed into this vessel are quickly joined, however dirty they may be.

SIGNOR GUGLIELMO, of Turin, finds that with potentials less than 600 volts, moist air insulates as well as dry air, but with higher potentials, there is more loss in moist air, and more the moister the air, and the higher the potential. The potential at which the difference becomes perceptible is the same for a ball as for a fine point. *Nature* says it occurs with extremely smooth surfaces, and so cannot be attributed to discharges in consequence of roughness of surface. With equal potential the loss of electricity has the same magnitude, whatever the dimensions of the balls used as conductors. In air saturated with vapours of insulating substances, the loss of electricity of a conductor is nearly the same as in dry air.

AT the meeting of the Chemical Society on November 17th, a paper was read on "Zinc-copper and Tin-copper Alloys," by Mr. A. P. Laurie. The author finds that if the zinc plate of a Daniell cell be replaced by a compound plate formed by joining copper and zinc, the cell has the same electro-motive force as one in which zinc alone is used; this is true even though the zinc surface be only $\frac{1}{1000}$th part of the copper surface. If the zinc plate be replaced by copper-zinc alloys, no deflection of the electrometer is observed as long as the alloy contains less than 67 per cent. of zinc; at this point, however, a big deflection, practically equivalent to that given by zinc, is suddenly obtained. This result, in the author's opinion, may be taken as evidence of the existence of a compound of the two metals of the formula $CuZn_2$. Alloys containing a greater proportion of zinc behave like zinc alone. Similarly in the case of tin-copper alloys, a sudden rise of electro-motive force is observed when the proportion of tin in the alloy exceeds that which would be contained in a compound of the formula Cu_3Sn. This result is in harmony with the evidence already obtained by observations of the density and thermal and electrical conductivity of the copper-tin alloys. If an alloy containing a larger percentage of tin than Cu_3Sn, in a state of fine division, be placed in a copper cup and used in place of the zinc in a cuprous chloride cell, the excess of tin is gradually eaten out, leaving approximately the alloy Cu_3Sn; this alloy undergoes no change if the circuit be kept closed.

MR. H. ALLEN HAZEN has contributed an article to the *American Journal of Science* for October on the relation between wind-velocity and pressure, giving a summary of the better class of experiments, the methods employed, and the results arrived at, from those of Borda, in 1763, to the present time. The methods of investigation generally adopted are (1) carrying a plate either in a straight line or in a circle; and (2) allowing a current of air to impinge normally upon the plate. The results of Borda's observations are expressed in the formula $p = (\cdot 0031 + \cdot 00035c)sv^2$, in which p = pressure in pounds; c = contour of plate in feet; s = surface in square feet; and v = velocity in miles per hour. In some careful experiments made at Washington in 1866, the formula obtained, viz., $p = (\cdot 0032 + \cdot 00034c)sv^2$, shows a remarkable and unexpected coincidence with Borda's results, with an entirely different apparatus. By far the most careful experiments with a whirling machine were those of Hagen, in 1873, with plates varying in size from 4 to 40 square inches in area. His formula is $p = (\cdot 0029 + \cdot 00014c)sv^2$; and these results have been used by Prof. W. Ferrel in his recent discussion of this question. Various other experiments are discussed, including those lately made in France on a train running at increasing velocities, which gave the formula $p = 000535sv^2$. The author expresses the opinion that further experiments are much needed, with larger plates than 2ft. square, and with high velocities with a straight-line motion. In connection with this subject it may be mentioned that the Royal Meteorological Society have appointed a Wind-Force Committee to consider the relation existing between velocity and pressure, together with other anemometrical questions, and a preliminary report was read in the spring of this year.

ACCORDING to the *Bulletin de la Ceramique*, it is known that the caustic lime which is not in a state of combination in cement saponifies the oil used in painting. Consequently painting on cement is only practicable when, under the influence of the air, carbonic acid has united with the caustic lime to form carbonate of lime. When it is desired to paint cement without delay, attempts are sometimes made to neutralise the lime by acids; but the above-named journal recommends in preference the use of carbonate of ammonia, the acid of which combines with the lime while the ammonia is liberated. The effect produced is, however, only superficial. Various other expedients are referred to, but the solution of the problem would seem to consist in the use of caseine. Fresh white cheese and slaked fat lime are added to the colour. This mixture hardens rapidly, assumes the consistency of stone, and is insoluble in water, a formation of albuminate of lime taking place. It is according to this system that the mural paintings at the Berlin War Museum were executed. To make the composition, three parts of cheese and one of slaked fat lime are stirred, the quantity of colour to be added being regulated by practice. Only earth colours or oxides of iron would be used for light red to dark brown shades; for blue, ultramarine or cobalt blue would be used; for white, oxide of zinc or sulphate of baryta; and for black, animal black. Inorganic colours, such as those of aniline, would not be used, nor would Prussian blue, vermillion, blue ochre, and white lead be employed, on account of the injurious effects of the sulphur present in the cheese in combination with these substances. The caseous lime should be prepared daily, and the brushes should be cleaned after the application of each coat of paint. The process thus described is recommended for its economy, the walls of a house being painted as fast as the scaffolding is removed. The caseous paint does not easily take fire.

MISCELLANEA.

MESSRS. ALEXANDER SHANKS AND SON, engineers, of Dens Ironworks, Arbroath, have changed their London office address from 27, Leadenhall-street, to 110, Cannon-street, E.C. Their warehouse and show-room will be at 44, Tenter-street East, Goodman's-fields, E.

THE deposit of plans for private Bills intended to be proceeded with next session was completed on the 30th ult. The total number of plans deposited is 157, which are divided as follows:—Railways, 58; tramways, 15; provisional orders, 38; miscellaneous, 46. Last year the total was 132, consisting of 47 railways, 12 tramways, 40 provisional orders, and 33 miscellaneous.

SPEAKING of the proposed meeting of the Iron and Steel Institute in America next year, the *Railroad Gazette* heads a paragraph, "The British will be welcome," and says that "A visit of the kind contemplated would be pleasant and advantageous to all parties, and would remove a great deal of the prejudice many of the members have to this country."

SOME little time back the Local Board of Walton-le-Dale advertised for schemes for the sewering and disposal of the sewage of their district. In response to this many schemes have been sent in from some well-known engineers. The ultimate decision as to the merits of the various schemes was submitted to Mr. Thomas Fenwick, C.E., of Leeds, and he has just awarded the first premium to Mr. William Wrennoll, C.E., of Liverpool, and the second premium to Messrs. H. T. Johnson and Co.

FROM latest reports received at Washington it appears that the preliminary trial of the monitor Terror at Philadelphia was, in the main, a success, although, owing to the absence of lagging on the boilers and steam pipes, the radiation of heat was so great as to materially modify the performance of the main engines in the development of horse-power, while the temperature on the first day rose to no less than 201 deg. Fah. in the fire-room. Of course no human being could stand such heat, so the trial was postponed until some modifications were made in the forced draught system. After this was accomplished the trial was carried to a successful issue, the draught blowers reaching a speed of 600 revolutions per minute for twenty-four hours without a hitch of any kind. The trial is regarded as successful.

THE Pulsometer Engineering Company is introducing what it terms a Regenerative Freezing Apparatus, for which it claims great economy in working, and very small consumption of fuel for a given amount of work, whether in ice making, cooling liquids, or refrigerating meat and provisions. The saving in cost of fuel and labour being, they inform us, strikingly apparent when compared with what are generally known as cold dry-air machines. The regenerative system of refrigeration has been carefully tested in continuous operation for nearly two years before being adopted by the company, who state that as much as fourteen tons of ice can be guaranteed from the expenditure of one ton of coals, and that the enormous number of 60,000 carcases of meat can be maintained in a frozen condition at a temperature approaching zero with the consumption of about two tons of coals in twenty-four hours.

A LETTER from Bermuda tells us that H.M.S. Canada twisted her ram in a collision, and it was taken off at Halifax and brought to Bermuda on the deck of the Canada, to be refitted. The ram is a solid brass casting, weighing about eight tons, which forms the main stem. The part twisted being taken off, leaves an opening about a foot wide, going up the bow about 15ft. The ram also forms part of the main keel, running aft about 30ft.; about 10ft. of that part removed leaves another bad opening. All the damage done is right forward below the water line. The Canada had a temporary bow made of wood while coming to Bermuda. At the date of our correspondent's letter there were about twenty-five shipwrights working on the Canada from 6.30 in the morning until 9.15 at night, having only half-hour at dinner; and it is probable that she will not be out of dock until Christmas. The moulders had received orders to cast 3000 brass bolts for the Canada.

THE death is announced of Mr. John Benjamin Dancer, a Manchester optician to whom many important inventions are due. Mr. Dancer was born in London in the year 1812. He settled in Manchester in 1835, and soon made his mark in scientific circles. He was elected a member of the Literary and Philosophical Society, and Fellow of the Royal Astronomical Society. He was the first to suggest the application of photography in connection with the magic-lantern, and he followed it up by other improvements. He also constructed the optical chromatic fountain, an idea which has since been further developed at South Kensington and Old Trafford, Manchester. Dr. Dance's services in connection with electricity and photography were of a valuable and important nature. Further, Dr. Joule states that the first thermometer made in England with any pretensions to accuracy was constructed by the deceased. He was also successful in producing microscopes which, while fully equal to the requirements of original research, were within reach of working-men naturalists. During the later years of his life Mr. Dancer's pecuniary circumstances were of a straitened character, and he also suffered from total blindness.

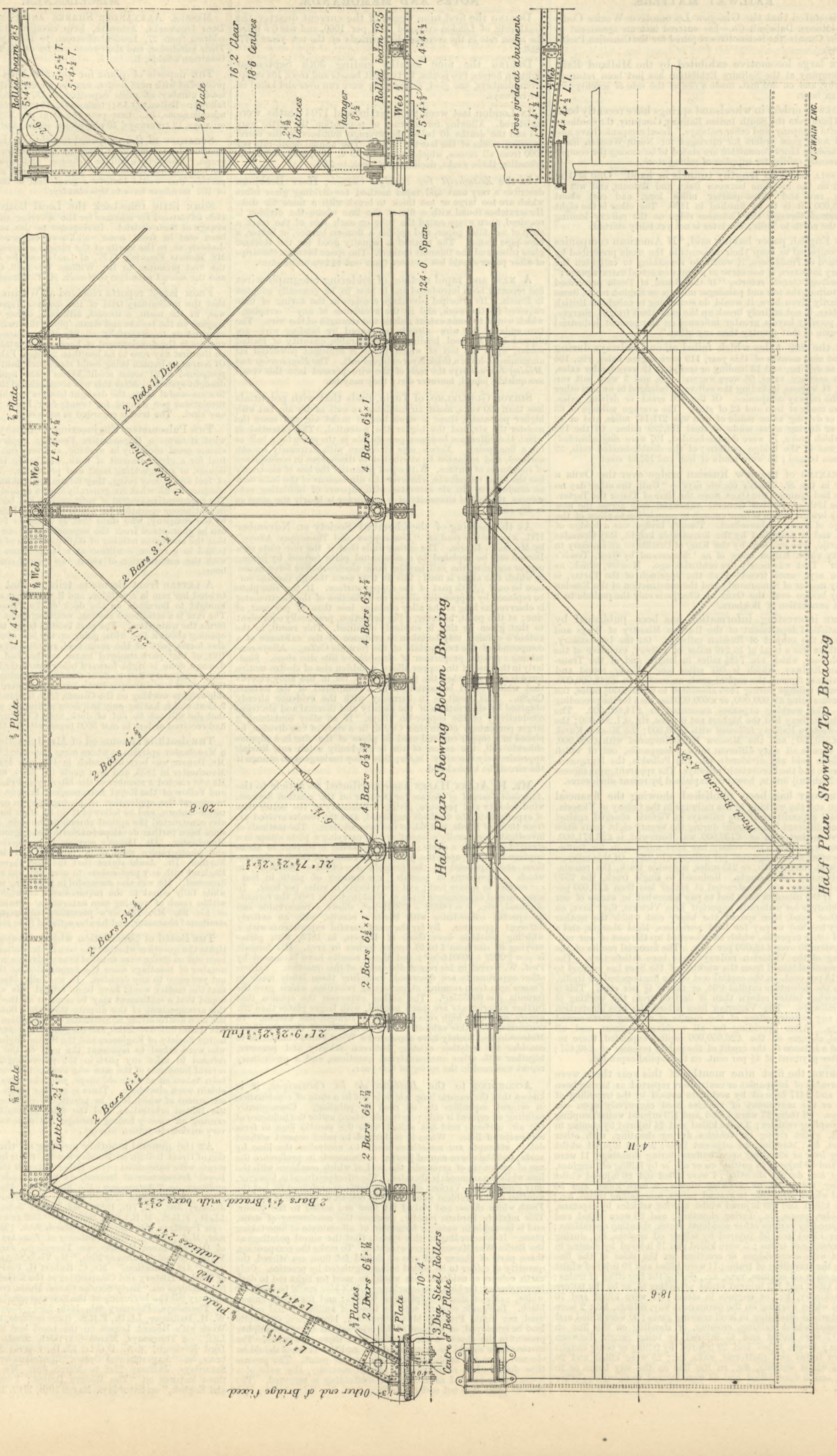
THE Board of Conciliation which was appointed to investigate the question whether the men in the Bolton district who had been out on strike were entitled to any advance in wages, has held a number of meetings since the termination of the strike, but has not yet come to any decision. It was fully expected by the men that the matter would have been settled this week, and it is now hoped that a settlement may be come to at the next meeting. In this arrangement of the dispute through a Board of Conciliation the men are receiving no assistance or recognition from their respective trades union societies, and the general secretaries of the Amalgamated Society of Engineers and the Steam Engine Makers' Society, who were asked to represent the men on the Board, absolutely refused to take any part in the proceedings. There are still several hundreds of the men who went out on strike who have not been taken on at their old shops, and who have not been able to obtain work elsewhere. There is another strike at Blackburn, the settlement of which is to be practically governed by the result of the Bolton arbitration, and the delay in coming to a decision is causing an uneasy feeling amongst the men, many of whom are very anxious to return to work.

AT the general monthly meeting of the Royal Institution of Great Britain on Monday last the following lecture arrangements were announced:—Sir Robert Stawell Ball, LL.D., F.R.S., Royal Astronomer of Ireland, six lectures, adapted to a juvenile auditory, on "Astronomy: the Sun, Moon, Planets, Comets, and Stars," on December 27th—Tuesday—December 29th, 31st, 1887; January 3rd, 5th, 7th, 1888. Mr. George John Romanes, M.A., LL.D., F.R.S., M.R.I., ten lectures—"Before and After Darwin"—on Tuesdays, January 17th to March 20th. Mr. Hubert Herkomer, M.A., A.R.A., Slade Professor of Fine Art in the University of Oxford, three lectures—on Thursdays, January 19th, "The Walker School;" January 26th, "My Visits to America;" February 2nd, "Art Education." Mr. C. Hubert H. Parry, M.A., Professor of Musical History and Composition at the Royal College of Music, four lectures on "Early Secular Choral Music, from the Thirteenth Century till the beginning of the Seventeenth," with illustrations, on Thursdays, February 9th, 16th, 23rd; March 1st. The Rev. W. H. Dallinger, LL.D., F.R.S., three lectures, on "Microscopical Work with Recent Lenses on the Least and Simplest Forms of Life," on Thursdays, March 8th, 15th, 22nd. The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., M.R.I., seven lectures, on "Experimental Optics," illustrated by electric light, on Saturdays, January 21st to March 3rd. Mr. William Archer, three lectures on "The Modern Drama; French, Scandinavian and English," on Saturdays, March 10th, 17th, 24th.

THE SIEE HO BRIDGE, CHINA RAILWAYS.

MR. C. W. KINDER AND MR. JAMES CLEMINSON, MM. INST. C.E., ENGINEERS.

(For description see page 450.)



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TO CORRESPONDENTS.

Registered Telegraphic Address "ENGINEER NEWSPAPER, LONDON."

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

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PERPETUAL MOTION.—*Emphatically no.*
C. J. L.—*The address is quite right, but there is no exhibition.*
TUBAL.—"*Treatise on Metalliferous Minerals and Mining,*" *by D. C. Davies, and* "*Mining and Quarrying,*" *by J. H. Collins (Weales' Series), both published by Lockwood and Co.*
J. A. H. (Tralee).—*You cannot pump water at all under the conditions. The bucket of the pump must not be more than* 15ft. *above the level of the water in the well, to insure regular action.*
G. S. H.—*We do not think anything could be gained by the publication of your letter. It is more than probable that the invention will next be heard of in the law courts on a question of novelty.*
G. S. H.—*It is quite possible that in a particular case you effected a saving of* 35 *per cent., or even of* 80 *or* 90 *per cent.; but it does not follow that you could, under any and every circumstance, effect a saving.*

MASOUTA.

(To the Editor of The Engineer.)

SIR,—I notice an inquiry in your impression of the 18th inst. *re* "Masonta." It struck me this might be an error for "Masouta"—naphtha residue. If it is I will be very happy to give any information in my power.
G. B. FROOM.
Nijni-Novgorod, Russia, November 30th.

BAND SAWS.

(To the Editor of The Engineer.)

SIR,—Can any correspondent inform me why it is that band saws crack in various places? I have several new saws lately which are utterly ruined through being cracked in so many places. Is there any other metal, such as phosphor bronze or gun-metal, that could be made to answer better?
J. R.
December 4th.

FLANGING STEEL PLATES.

(To the Editor of The Engineer.)

SIR,—Will any of your readers kindly tell me what is the force required to flange steel plates cold, say 0·4in. thick? I want to know what pressure I should have to apply along a strip of such a plate, 3in. wide and 4ft. long, to bend it to a right angle cold. I can find no information on the subject in any book, paper, or treatise.
FERRUM.
Sunderland, December 5th.

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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon 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.—Tuesday, December 13th, at 8 p.m.: Ordinary meeting. Paper to be further discussed:—"Electrical Tramways: the Bessbrook and Newry Tramway," by Edw. Hopkinson, M.A., D.Sc., Assoc. M. Inst. C.E. Friday, December 16th, at 7.30 p.m.: Students' meeting. Paper to be read:—"River Gauging at the Vyrnwy Reservoir," by John H. Parkin, Stud. Inst. C.E.; Professor W. C. Unwin, B.Sc., F.R.S., in the chair.

SOCIETY OF ARTS.—Monday, December 12th, at 8 p m. Cantor lectures: "The Elements of Architectural Design," by H. H. Statham. Lecture III. —The statical conditions of the arched method of covering—Distinction between the column and the buttress—The "waggon" vault—The dome and domed architecture—The development of the vault—Transition from Romanesque to pointed architecture—Constructive origin of the pointed arch—Its development into the complete Gothic style—Comparative analysis of Greek and Gothic styles.—Wednesday, December 14th, at 8 p.m.: Ordinary meeting. "Commercial Education," by Sir Philip Magnus; Sir Douglas Galton, K.C.B., F.R.S., Chairman of Council, will preside.

CHEMICAL SOCIETY.—Thursday, December 15th, at 8 p.m. Papers to be read:—"An Apparatus for Comparison of Colour Tints," by A. W. Stokes; "The Sulphonation of Naphthalene," by Dr. Armstrong and W. P. Wynne, B.Sc.; "Isomeric Changes in the Naphthalene Series Nos. 1, 2, 3, and 4," by Dr. Armstrong and Messrs. Amphlet Williamson and Wynne; "Note from the Chemical Laboratory of the Yorkshire College, Leeds—(1) The Reduction of Chlorates by the Copper-Zinc Couple; (2) The Oxidation of Oxalic Acid by Potassium Bi-chromate; (3) A Method of Separating Supernatant Liquids," by C. H. Bothamley; "The Alloys of Copper and Antimony and of Copper and Tin," by E. J. Bell, Ph.D.

SOCIETY OF ARCHITECTS.—Tuesday, December 13th, at St. James' Hall, Piccadilly, W., at 7 p.m.: Ordinary meeting. Paper to be read:—"The Relations of Architect, Surveyor, and Builder," by Mr. J. Leaning, Member.

THE ENGINEER.

DECEMBER 9, 1887.

THE UNITED STATES' NAVY.

THOSE who believe that nothing right can be done by the British Admiralty, while everything done by the naval administrators of other nations must be right, may learn something from the report—just issued—addressed by Mr. George W. Melville, Chief of the Bureau of Steam Engineering, to the Hon. W. C. Whitney, Secretary of the United States' Navy. They will find therein ample evidence that even Americans can make mistakes and perpetrate red-tape blunders, quite equal in magnitude to anything that is to be met with at this side of the Atlantic. Mr. Melville is very outspoken, and uses language which certainly does not lack strength. The sums appropriated to the use of the Navy are comparatively small, and, as a consequence, the Bureau is often in difficulties, and compelled to resort to expedients which are creditable to the officials though not to the nation. The practice known as "robbing Peter to pay Paul" seems to be in much favour. It has, however, the drawback that what suits Peter will not always fit Paul. Thus, for example, we are told that the old engines of the Kearsarge were found to be unfit for further service, and have been taken out. As the hull will not last very long it was deemed unnecessary to build new engines for her, and so the engines taken years ago out of the Nantasket have been put into her. These engines are much too small for the ship; but, says Mr. Melville, "they are the best that could be put in under the circumstances," as there were no boilers for her two have been taken out of the Swatara and two from the Alliance, and the deficiency in these vessels has been made up by using forced draught. This seems to be economy with a vengeance; and we venture to think that, on the whole, it might have been cheaper to break up the Kearsarge, or to lay her up for the sake of the memories which cling to her, than to fit her out by such desperate expedients.

Perhaps the most interesting portion of the report is that which deals with the *personnel* of the engineer corps. It is said that in this country we could not embark on a naval war for lack of engineers and firemen. In the United States, as far as engineers are concerned, they are not better off. Congress has gone on reducing the numbers in the whole staff on service last October counted but 223. The Bureau being already embarrassed in the assignment of officers in such a manner that the machinery of vessels in commission may be properly cared for, and at the same time the multifarious duties on shore properly attended to, "it is difficult to foresee," says Mr. Melville, "what is to be done when the *personnel* of the engineer corps becomes reduced to the legal limit of 170, and when the number of engineers required on board of each vessel in commission will be so much greater, on account of their complicated machinery, than any vessels now in service. The number of engineers detailed to duty as professors of marine engineering at colleges has had to be reduced, and such details will very soon have to be stopped altogether, unless some provision is made for stopping the decrease in the *personnel* of the corps. The reduction in the number of passed-assistant engineers makes promotion very slow for the assistants, and has a very discouraging effect upon them. I would recommend that, if possible, the number of passed-assistant engineers should be increased to the former number of 100. The least that should be done, however, is the immediate stoppage of the reduction and the annual appointment of a sufficient number of the lower grade to make up the national loss." Mr. Melville calls attention to the injustice done to engineering students in assigning them relative ranks, cadet midshipmen taking precedence of cadet engineers. Both the Navy Department and Congress have been from time to time appealed to to correct this injustice by making all graduates of the Naval Academy rank with each other according to relative merit at graduation, but none of these efforts have thus far proved successful. These officers are put to great inconvenience by being thus left behind other officers of the service with whom they first entered upon the regular duties of the Navy as commissioned officers. "I would recommend, says Mr. Melville, that in their case also the Department should invoke the assistance of Congress."

In days gone by engineers in the British Navy suffered many hard things at the hands of commanding officers. In some cases this was due to the circumstance that the engineers of the period were in no sense or way, either by manners or education, gentlemen. Things are very much better now. The social status of the engineer has been raised, and his importance is recognised to a very considerable extent, albeit not so fully as is desirable. In the United States Navy, however, captains do not seem to have much sympathy with engineers, or else they permit red-tape to control them to—for the engineers—a very unpleasant degree. Some captains are better than others. "Many commanding officers," however, we are told, "arrange watches to suit themselves, often requiring engineers to stand regular watches in the engine-room, day and night, whether there is anything to demand their attention or not. Standing a watch, as does the officer of the deck, with military duties to perform, is one thing; and standing watch, as engineers are frequently required to do, over a mass of cold cast iron, is quite another. It is neither inspiriting nor healthful to the victim." We quite agree with Mr. Melville, and hope that his suggestion may be adopted, that the Engineer Department should be permitted to settle engineering details. As we read the report it recalls, page after page, statements that have been made time and again concerning our own naval administration. Notwithstanding its length, we make the following quotation:— "As an instance of the inconsistent way in which men are apportioned to the different vessels, it may be mentioned that the Boston and Atlanta have each a smaller engineer's force than the Trenton, which has similar machinery but a quarter less power. Moreover, the machinery of the former vessels is in several water-tight compartments, and for this reason alone needs more men than the latter, which is all in one compartment. Another case is that of the Alliance, which has fewer boilers than others of her class, but is able by forced draught to develope more power; nevertheless she is allowed fewer coal trimmers than her sister ships. To make matters worse, the importance of the work of these men in the engineer's department is in many cases made secondary to that of work on deck. The firemen are kept on deck by the hour and exercised in the manipulation of the spars and sails, while the work below is neglected. Not very long ago, on board a ship which is full of machinery, the chief engineer complained that he was unable to do the necessary overhauling and repairs, as he was not allowed the use of his men. The reply of the commanding officer was that the presence of the men at the drills could not be dispensed with, and that if repairs to the engines were necessary they could be done at night. The result of such action is inefficiency of the motive power and unduly rapid deterioration of the boilers and machinery. The average life of our boilers is less than it should be, and many of our engines, although originally economical, have become wasteful of fuel simply from want of attention, while the labour which should be used on them is diverted into other channels. This must all be changed, and changed quickly, if our vessels are to be kept in effective condition. The department enlists men for the engineer's force for the purpose of manipulating and taking care of the machinery, and they should not be employed for other purposes while this work remains undone. None of these men should be employed in any work other than that for which they were intended, without the previous statement of the engineer in charge that his department is in such a state that their services can be spared, this statement to be recorded in the steam log-book. The coal trimmers should be considered as a permanent part of the engineer's force, as was intended when the rating of coal trimmers was established." We could find in the back volumes of THE ENGINEER passages almost identical with the foregoing. It would seem indeed as if everything connected with the American navy was about a quarter of a century behind the age.

Engineers being so scarce, it might be imagined that they would be supplemented, as in our own navy, by a staff of engine-room artificers; but this is not the case. The artificers cannot be got under the conditions. It is impossible to get as good a class of machinists and petty officers of the artificer class as is desirable. This is not so much on account of the pay—although this should be greater in some cases—as the conditions of life to which these men are subjected on board ship. "Few mechanics who can earn good wages on shore are willing to go to sea when they must swing in a hammock, eat out of a tin pan, assist in all sorts of drudgery, be 'horsed' around generally, and be permitted to go ashore only at long intervals. The services of good men are necessary to the efficiency of our ships, and every effort should be made to obtain such. The petty officers of the higher grades should be kept apart from the other men as much as possible, otherwise they lose to a great extent their influence over them. I see no reason why the machinists, together with a few certain other petty officers, should not have a place on the berth-deck partitioned off for their use where they could have comparative privacy. This could be very easily done on some of the more recent vessels where the division of the vessel by numerous water-tight bulkheads lends itself to such an arrangement. These men should also be allowed greater privileges than the minor enlisted men in the matter of 'liberty' on shore. They should be furnished with lockers in which to properly keep their clothing, and with facilities for maintaining a decent mess."

The more carefully the report is studied the more glaring do the defects in the administration of the affairs of the republic become. There is nothing in this wretched old worn-out country much worse than we can find at the other side of the Atlantic. What do our own naval reformers think of the fact that there are four different departments to supply steam machinery to ships, and that three departments have charge of it in ships in commission. Need we add that the departments do not work harmoniously. No wonder that Mr. Melville advises that changes be made in the system. He is also very desirous, and justly desirous, that full power runs should often be made. What he has to say on this subject is so sound in its reasoning that we make no apology in reproducing it here. "Our ships, after their first trials, are seldom if ever run at full power; hence it is never certain that the machinery will be equal to such a task when required, and the engineer's force, from lack of experience, is likely to be found wanting at a critical moment. If it is necessary for the efficiency of a vessel that its crew should be frequently drilled in the manipulation of the sails, guns, and small arms, it would be but reasonable to suppose that the firemen, and others of the engineer's force, would need some practice to enable them to become as proficient in their duties as the standard of excellence would require. It is a comparatively easy matter to run the machinery at two-thirds power; it is the last half-knot that counts. Every ship in commission should be tried at least once every six months, and more frequently if possible, for eight hours under full power. It would be better if a longer run could be made, but the number of men allowed will not permit of it, as at full power the watches have to be doubled, and the men cannot stand the strain. A part of this run should be made over a measured base in order to determine the exact speed. Each ship should also, once a year, be subjected to a progressive speed trial, over a measured base if possible. The results of these trials would give to the department a good idea of the efficiency of the machinery, and would be useful in many ways. A carefully kept record of the performance of each vessel is of the greatest use to the department, both in proportioning the machinery of new vessels and in improving that of existing ones."

Much remains to be noticed in Mr. Melville's report, and to this we may return. We have said enough, we think, to show that although "two wrongs do not make one right," our own naval administration is not exceptionally bad. We are a very outspoken people, and are never, it would seem, so happy as when we are decrying ourselves. If other naval Powers were less chary than they are of making their affairs public, it would be seen that they are, after all, not better off than we are. At least that seems to be one lesson that Mr. Melville's report teaches.

COAL IN SOUTH AFRICA.

It seems perfectly certain that until coal discoveries and the development of means of transport in the South African colonies enable a free supply of fuel to be obtained there is but little chance of the abundant deposits of gold found in various localities within them being profitably worked. Throughout South Africa generally there is a deficiency of two important necessaries towards the paying extraction of gold. Neither timber nor water is found either in sufficient quantity or sufficiently distributed to enable many apparently rich mines of gold to be worked with the economy which alone can make them paying concerns. We read of discoveries of mines, the crushings of which are reported to be exceptionally fruitful, and although we are cautioned by the temperate portion of the press of the South African colonies to receive with caution many of the very glowing accounts sent home for the temptation of English investor, we believe that it cannot be denied that there is every proof that South African goldfields are likely to prove profitable. But the disabilities above referred to must certainly operate to prevent successful mining. It is of little use extracting heavy percentages of gold from the quartz if the cost of doing so be in excess of the value of such percentage. But in the large majority of cases it is certain such has proved to be the result of gold mining operations hitherto in South Africa. As the first factor towards this excessive cost there is the very limited means of transport yet available by which the heavy machinery required can be sent to the localities in which the finest goldfields are situated. The ox wagon, with its ten to sixteen yoke of animals, is still in most places the only means available by which machinery can be got up to them. Breakdowns are constant over the unformed roads, and much of the machinery reaches its destination in an utterly irreparable condition. But the difficulties by no means cease even when the engines, stampers, &c., are erected. Then there have to be dealt with the scarcity of fuel and water, and enormous expenditure has to be incurred to make good the deficiency in those two important items. It may be taken for granted, we think, that, given a good supply of fuel, water may be raised anywhere at what would prove a comparatively trifling expense. Therefore coal would promote the supply of water The extended discovery and opening of coalfields is undoubtedly the prime necessity towards making the goldfields of South Africa pay in proportion to their alleged richness. There appears to be every prospect that there are few districts of any size in our colonies of the Cape and Natal which do not contain coal deposits in a greater or lesser degree. Many of these have been opened and partially worked, though their full development must await the extension of railways, and these are only likely to spread towards them as the settlers devote themselves less entirely than they do at present to agricultural pursuits.

More favoured than our own colonies of the Cape and Natal, appears to be the semi-independent Transvaal. To its inhabitants, and to the many thousands of all nationalities who are now flocking to it, attracted by the reports of the richness of its goldfields, the recent discoveries of coal within it must prove to be of the highest importance. They may, as we have above pointed out, turn unremunerative mining into an industry which must prove most profitable, though at the best, gold mining, like every other form of enterprise, seems likely to yield but what may be termed fair average returns upon the cost of conducting it. It is only the lucky discoverer who grows suddenly rich, and he is but one among thousands who fail. Of the late discoveries of coal in the Transvaal the principal mine is situated at some fifty miles from Johannesburg. It is now being worked, and its product already meets with a great demand throughout the goldfields along the whole length of Witwatersrand. It is also being freely used for household purposes, the sparseness of timber, of which we have before made mention as characterising South African colonies generally, making coal much cheaper fuel for such purposes than wood. To quote from the authority announcing this find:—"The property is known as the Venter's and Holspruit coalfields, and is situated on the banks of the Wilge river. The quality of the coal is declared by those who have used it, including the Stanhope, Knight's, and Wemmer's companies, to be excellent; and as it is being extracted from a seam near to the surface, there is every reason to believe that it will be better still when depth has been attained. The seam now being worked is not less than 19ft. 6in. thick, and the extent of the deposit is said to be simply incalculable." Further finds of coal are reported, though not with sufficient detail for us fully to state their character or value, within fourteen miles of Delagoa Bay; and if there be any reliance to be placed on this report, the find must add greatly to the value of the country through which runs the railway just opened through Portuguese territory from that Bay towards the Transvaal. We notice that there is a desire expressed to urge on the British Government the acquisition of a portion at least of that territory, by purchase or exchange. If it be possible to carry out that desire, there appears much to be said in favour of it. What with the fact that, on our own borderland, we are exposed to competition in the carrying-trade of an alien Power, and the additional fact that that trade communicates with the territory of a semi-independent State which is notoriously hostile to us, there is every reason why Delagoa Bay, its railway, and the country through which the latter passes, should be transformed, if possible, into British Possessions. The value of such an acquisition must be greatly increased by the recent discovery of coal; for coal, as we have pointed out, is vital in every way to the success of the great gold-mining industry of our South African Colonies. With facilities for transport increased, coal will remedy the deficiency so much felt of both wood and water, and enable the valuable metalliferous deposits which exist in South Africa to be profitably worked. Until this advantage is secured, these deposits are comparatively almost valueless, and the attention of the Imperial Government may well be directed towards aiding the measures necessary to obtain it.

RAILWAYS IN INDIA.

The three systems on which railways have been constructed and worked in India are the Guaranteed, the State, and the Assisted, each of which is sub-divided. The mileage open at the end of 1886 for British India was:—Guaranteed, 3928; capital, £60,763,058; proportion of working expenses to receipts, 49·37. State Imperial, 6168; capital, £90,488,941; proportion of working expenses, 44·44. State Provincial, 1384; capital, £10,291,593; proportion of working expenses, 62·53. Assisted, 587; capital, £3,423,367; proportion of working expenses, 59·32. In addition there were in the Native States 798 miles of railway with a capital of £5,531,952, and proportion of working expenses, 52·80. The totals were:—Miles open, 12,865; capital, £170,498,911; goods carried, 19,576,365 tons; passengers carried, 88,436,318; gross earnings, £18,704,536; working expenses, £8,930,983; net receipts, £9,773,553; proportion of working expenses, 47·75. The increases in each of the above over 1885 per cent. were:—Miles open, 5·32; capital, 5; goods carried, 3·44; passengers carried, 9·37; gross earnings, 4·26; working expenses, 0·78, net receipts, ·709, while the proportion of working expenses to receipts decreased 1·38 per cent. The increase in the receipts and traffic was spread over most of the railways, but was more marked in the case of the Great Indian Peninsula and Rajputana-Malwa Railways, which gave respectively 47 and 19 per cent. of the increase in the traffic receipts. The increase on goods traffic was considerable, and included 31 out of the 47 items tabulated. The improvement in the former railway was caused mainly by the recovery of the cotton and wheat trades. In consequence of scarcity of food grains in the Punjab, the carriage of wheat on the North-Western system declined considerably, which, combined with large expenditure on renewals of permanent way and rolling stock, and on the restoration of flood damages, caused a falling off in the net revenue of that system amounting to £200,000. The aggregate net profits realised in 1886 by all the Indian railways amounted to 5·9 per cent. on the capital outlay, a better return than in 1885, when the percentage of net receipts was 5·84. In the present statement the Scinde, Punjab, and Delhi Railway no longer contributes to the figures of guaranteed railways. It was purchased by the State on 1st January, 1886, and as a part of the North-Western system is included under the State railways. In the expenditure are included all charges falling on the Government for management and working expenses of railways, interest on capital outlay, control, land required by the companies, and miscellaneous items, such as head-quarters establishment and survey. After meeting all these expenses, the total charge to the State in 1885-6 was £731,713, a charge which, in the next few years, is expected to increase rather than diminish, as new lines likely at first to be unremunerative are being largely constructed. The railway mileage open on 31st March, 1887, had increased to 13,390, showing that in the twelve months then ended 1025 miles were completed and opened for traffic. In addition there were 3205 miles under construction or sanctioned. The chief sections of railway opened were 275 miles of the Sind Pishin and Sind Sugar sections of the North-Western Railway, 251 miles of the Southern Mahratta system, 87 miles of the Nizam's Railway, 73 miles of the Bengal and North-Western line, 59 miles on the Jodhpore State line, 55 miles between Lucknow and Situpur, 42 miles on the Indian Midland, 41 on the West of India Portugese Railway, and 39 between Bahraich and Naipalgang. The chief extensions sanctioned were 225 miles between Toungoo and Mandalay, 124 miles in Mysore, and 67 in Kathiawar. The East Indian Railway bridge over the Hoogly, and the Tirhoot Railway bridge over the Gunduck were opened in the spring of 1887. The bridges over the Ganges at Balawala and Benares for the Oude and Rohilkund line, the Indian Midland Railway bridge over the Jumna at Kalpi, the Jhelum Bridge for the Sind Sugar Railway, and the Sutlej bridge at Ferozopore were all within a few months of completion. The Sukhur Bridge over the Indus is the only one the construction of which has been delayed.

The original great trunk lines of India are due to the guaranteed companies in a contract between them and the Government that the latter gave the land required free of charge, and guaranteed interest at the rate of 5 per cent. on the share capital raised with its consent, and a lower rate upon debenture capital. A general supervision of the railway is also retained, and stores and troops are carried on favourable terms. If the net profits fall in any half-year below the amount of guaranteed interest, the Government makes up the deficiency. If they exceed the amount, the surplus is equally divided between the company and the Government, who have also the right of buying the undertaking at specified dates on payment of the value of the shares calculated at their market price on the average of the three preceding years. In this way the East Indian Railway was acquired in 1880, the Eastern Bengal Railway in 1884, and the Scinde, Punjab, and Delhi lines in 1885-6. In 1870 a new policy of railway development by the direct agency of the State was inaugurated; and in 1880-81 a return was made to the system of encouraging private enterprise by State assistance. The amount of assistance to the subsidised or assisted railways varies, but it always includes a free gift of the land, and carries with it the option of purchase by the State. The Government have placed before the public the financial results yielded by Indian railways as an indication to private enterprise of the returns to be expected from investments in future undertakings without a permanent Government guarantee. There are two railways on this basis, the Bengal and North-Western and the Turakessur Railway Companies, in both of which cases the results obtained have proved very satisfactory. The former opened in 1884, paying in 1886 3·63 per cent. on its capital outlay of £2,227,506; and the latter opened in 1885, paying in 1886 7 per cent. on its capital outlay of £168,899.

LEAD MINES AND LEAD.

The remarkable movements in the price of copper and of tin have now extended to lead, and there have been some sharp advances both in the price of lead and of products of pig lead. It is well known that between two and three years ago lead reached a very low range of prices. Three years ago, one of the chief producing companies sold its lead at a price as low on the average of one month as £10 4s. 8d.; and in the year 1885 the price over two months was £10 5s. 6d. per ton, but later on in that year there was a rather rapid rise, and the price before the end of the year was £12 5s. Although the whole of the increase was not maintained, yet the average price for 1885 rose to £11 10s. in London market, and for the past year it was as high as £12 4s. 9d. For the year 1885 the production of British lead was very low—it was only 37,687 tons, and the importation of lead was less than it had been; but the slight increase in the price of lead raised the output and also slightly raised the import. Last year our mines gave ores which yielded 39,482 tons of lead—a low production, though above that for the previous year, as we have shown. This year there has been, until the end of last month, a steady market for lead; but in the last week or two the market has shown some of the signs of that increase in prices by leaps and bounds which had previously characterised the copper market and that for tin. Lead rose until over £15 was paid for both Spanish and soft English lead; and white and red lead, with other lead products, rose with some rapidity also. The effect of this increase, especially if it continue, will be to cause some of the long-closed mines to be opened out, and to enlarge the production of one of the metals which has been long worked in this country, but which has felt more than most of our metallugical industries the keenness of the competition with foreign importations. It cannot be forgotten that whilst last year British lead was produced to the extent of only 39,482 tons, the lead imported and that smelted from foreign ores was as much as 135,512 tons. No doubt, this would be partly due to the richness of the imported ores and the silver lead brought in, but in part that large importation is contributed to by the fact that the royalties abroad are much less than those on the lead produced in this country; and it is by no means impossible that the foreign producers of lead may reap the bulk of the benefit which the rise in prices will give. The rise in prices will allow some closed mines to be opened out, and may do much good to districts depending in a degree on lead mining for the employment of considerable portions of the population; but there will still be the inequality of competition between the home and foreign ores, which arises from the higher cost of production here, and from the larger toll taken by the owners of the royalties.

ENGLISH AND CONTINENTAL RAILWAY TRAFFIC CHARGES.

We lately referred to the statements of Lord Henniker, Chairman of the Railway Rates Committee, concerning the admission by the London and North-Western, and Great Western Railway Companies, that the charges which they have recently been making for the conveyance of undamageable iron over certain of the Birmingham routes have been greatly in excess of their legal powers. Striking information is just now forthcoming on the respective positions of our home and Continental traders in this matter of railway and canal freights. The authority of statistics demonstrates that while our manufacturers have to pay an average rate of 1·06d. per ton per mile, to get their iron and steel to the seaboard for export, the cost to some of our continental competitors is nearly 100 per cent. less. In France the cost is ·38d.; in Germany, ·54d.; in Belgium, ·86d. There is one argument which may be used by the railway companies here when it is claimed that English rates should be brought down to the same as continental, namely, the great cost of our railway construction and maintenance as compared with those of the Continent, and the fact that railway investments in this country have barely averaged 4 per cent. interest. But this cannot be accepted as sufficient justification for so great a difference. Home manufacturers, too, want an explanation of why it is that girders are brought from Belgium to Sheffield for 15s. per ton, whereas for the conveyance of Sheffield-made girders to Grimsby 20s. per ton is charged. Also, why it is that foreign iron castings should be conveyed from West Hartlepool to Leeds at 11½d. per ton when English castings have to bear a rate of 16s. 8d.; and, why 12s. 6d. per ton only should be charged for carrying foreign castings from Newcastle to Leeds, when on home manufactures the rate is 20s. Reform is urgently needed, and reform must take place.

LITERATURE.

A Treatise on the Integral Calculus. Part I. Containing an Elementary Account of Elliptic Integrals, and Applications to Plane Curves. By RALPH A. ROBERTS, M.A. Dublin: Hodges, Figgis, and Co. London: Longmans, Green, and Co. 1887.

IN style of printing, and in the general arrangement of its contents, this book will infallibly suggest to the student his old and valued friend "Williamson," and a cursory inspection will confirm the impression that Mr. Roberts' work is practically an expansion of the first eight chapters of its predecessor, by the addition of about half as much again of new matter—notably including an excellent chapter on the elementary properties of elliptic integrals. Mr. Roberts' style of treatment is, however, as fresh and original as the nature of his subject will admit; the additional theorems introduced by him are for the most part highly valuable, and he does not hesitate to avail himself of the modern higher algebra and geometry for the supply of instructive illustrations and examples. He is also to be congratulated upon having secured for elliptic functions that permanent claim to adequate recognition at the hands of elementary authors which has been so lately ceded to determinants.

The first chapter, on elementary integrals, follows closely on Williamson's lines, starting from the same conception of integration as a process converse to differentiation. In Article 18 there is a valuable general theorem on integration by parts, and Articles 20, 21 introduce the method of integration by reduction to homogeneous functions of two variables, which is employed with such effect in the next two chapters. Chapter II., on the integration of rational functions, includes (Article 34), the reduction of the general integral $\int U_{n-2}\,(x\,dy - y\,dx)/U_n$, where U_n denotes a homogeneous function of x and y, of any even order n. In Chapter III., on rationalisation, the only point calling for special remark is the general transformation—Articles 39, 42—of the integral

$$\int f(x)\,dx/\phi(x)\sqrt{a + 2bx + cx^2},$$

which is here effected by rendering the expressions involved homogeneous in two variables, and applying the results previously obtained. In Article 42 we have the case of the recurrent biquadratic radical. The next chapter contains the general formulæ for integration by successive reduction, with the usual applications. The author has wisely included the detailed discussion of the integral $\int \sin^m\theta\cos^n\theta\,d\theta$, which has saved so much labour to the readers of Williamson.

Chapter V. is devoted to an elementary discussion of Elliptic Integrals, considered chiefly with regard to their geometrical applications. Commencing with the expression of the general integral, involving only one biquadratic radical, in terms of the standard forms F, E, Π, we proceed to the fundamental addition formulæ, to Euler's and Lagrange's investigations of the general differential equation, and to the connection of the amplitudes with the spherical triangle. The inverse notation is then introduced, and the general formulæ for sn $(u + v)$, cn $(u + v)$ dn $(u + v)$ are given, followed by a discussion of the periodic values of the elliptic functions. The remainder of the chapter consists of a proof of Landen's transformation, with geometrical illustrations, and the application of Abel's theorem to integrals of the first kind. From the paragraph at the foot of page 123 we infer that Mr. Roberts intends to include a more advanced chapter on this subject in his Second Part.

The chapter on Definite Integrals introduces the notion of integration as a process of summation, and hardly differs from the corresponding chapter in Williamson's work, excepting that Frullani's theorem and the table of values of log. Γ (n) are omitted.

The two concluding chapters on Mensuration and Rectification are the most characteristic in the book, the author's additions in the preceding chapters, and especially his introduction of elliptic functions, enabling him to discuss geometrical examples of a more advanced and more general character than previous elementary writers have ventured upon. Thus, in Chapter VII., besides the demonstration of the stock formulæ for areas, and the usual theorems relating to pedals, envelopes, evolutes, parallels, and roulettes, the student will find full instructions for the expression of the areas of the general cubic and the bi-circular quartic in terms of elliptic integrals, and an excellent article on unicursal curves. Chapter VIII. includes the theorems of Graves, Fagnani, Landen, MacCullagh and Chasles on the rectification of central conics, Casey's general reduction of the arc of a bi-circular quartic to elliptic integrals, and Serret's rectification of the Cassinian oval. There is also a discussion of the general problem of the generation of curves whose arcs shall be expressible in terms of circular functions, logarithms, or elliptic functions of the first kind, illustrated by a full investigation of one class of Serret's curves. The chapter concludes with McCay's theorem on the rectification of the envelopes of the sides of a rigid rectilinear figure moving in its own plane.

There are some 800 excellent examples, mostly distributed throughout the book in small groups, and there is an index. There is no preface, and—with the single exception referred to above—the author affords no information as to the contents of Part II.; but we are confident that every reader of the present instalment will look forward with interest to its appearance.

The Pump Catechism: a Practical Help to Runners, Owners, and Makers of Pumps of any kind. By ROBERT GRIMSHAW, M.E. New York: J. Wiley and Sons. London: Trübner and Co. 1887.

THE title of this very small book, partly given above, continues as follows:—"Covering the Theory and Practice of Designing, Constructing and Erecting, Connecting and Adjusting;" and a dedication is "To every one who wishes to know more to-morrow than he did yesterday." There is also a somewhat boastful and egotistical preface. The greater part of the book is taken up with questions and answers concerning various forms of the small horizontal pump generally known in England as the special or direct-acting type. Except for the engravings of these and their valve gear, the book would have no value in this country; and these do not give it much, although we are told in the preface that "much of the special information herein had to be got by begging, coaxing, arguing, and almost threatening, and can be had in no other form and in no other place." There is some reason for thankfulness to be extracted from this latter remark.

Practical Handbook on Pump Construction. By PHILIP R. BJOERLING. London: E. and F. Spon. 1887.

THIS is a small useful book descriptive of typical reciprocating pumps and pump parts most occurring in engineering practice, and with accompanying instruction and hints of a practical character. The chief rules for calculations necessary in ordinary pump work are given with examples; some typical forms of pumps and valves, plungers, and other parts are shown in clearly executed lithographs, and the work is one that was much wanted. It is a good book, for it gives what men who wish to make pumps want to know. It tells what size, what form, and of what materials a pump should be made, whether it be for water or for acids or anything else that can be pumped, and it also tells many of the little things that practical experience teaches about pumps. Centrifugal and other rotary pumps are not treated. Hydraulic rams are not mentioned, and although reference is made to earthenware, glass, and gutta-percha lined pumps, drawings are not given of these. The author might add to his book by including all these, and some illustrations of one or two of the special or small direct-acting pumps, in a future edition. He makes one mistake in the first paragraph in the book. He says "A pump in its most common form . . . consists of a barrel, bored perfectly true, and parallel," &c. The most common form of pump is quite innocent of all boring operations, and few have been accused of having perfectly parallel bores. This charity, however, on the part of the author towards common pump makers may be forgiven, and it does not detract from the high commendation which his little book should receive.

FLY ROPES.

WHEN power is transmitted over considerable distances by an endless rope, running at a high velocity, that rope is termed a "fly rope." The system is much used in this country for driving travelling-cranes, principally used for carrying heavy machinery from one place to another in large engineering shops. There are, no doubt, an abundance of data in existence concerning the wear and tear, &c., of fly ropes; but we are not aware that any compact information on the subject has been made available, and the particulars which we are about to place before our readers will accordingly, we think, be found to possess a special interest. The American Institute of Mechanical Engineers has introduced an admirable innovation into its practice at certain of its meetings; instead of papers being read, questions or problems are put and information and discussion are asked for. These are known as "Topical Discussions and Interchange of Data." The last volume of the "Transactions" of the Institution contains several examples. One question put was, "What are the best conditions for flying-rope transmission of power? Are there limitations to its uses!" We propose to give here a digest of the statements made by the various speakers who took part in the discussion which followed the enunciation of the questions above.

In some cases much trouble is caused by the vibration of the rope between the pulleys. Any species of support used to arrest this vibration is rapidly cut away. It was suggested that small discs might be used, the rope acting not on the edges but on the face of the discs, which would continuously offer new surfaces of contact. To us it appears that the proper remedy would lie in altering the tension of the rope. Some years ago one of the speakers used wire-rope transmission on Hirn's system to drive tools, and a blacksmith's shop using a power hammer and a fan. Large pulleys with leather fittings at the bottoms of the grooves were employed. The whole arrangement proved unsatisfactory, the ropes wearing out rapidly—a result, we may add, quite in accord with those obtained in other instances where wire-rope transmission has been tried. In the early history of Sibley College a ⅝in. wire rope was employed to transmit power over a distance of 1100ft. from a water-wheel in a gorge below the College. Great difficulties were encountered first in putting up the rope and then in maintaining it and keeping it in running order. It took three years to find how to run it and avoid vibrations, and finally an attempt was made to discover the cause of the vibrations. It was at last made out that they were due to a slight tremour in the groove of the driving pulley, and by turning the groove dead true nine-tenths of the troubles were got rid of. In another case a wire rope over a span of 250ft. gave much trouble. Finally it broke, and was hastily replaced with a 1¼in. Manilla rope to save time; but the Manilla rope, transmitting about 24-horse power, worked so well, that it has quite superseded the wire rope, and gives perfect satisfaction. The grooves in the wheels are filled with alternate layers of india-rubber and leather, and turned true in their own bearings. One of the speakers using three lines of fly rope, found them last well save at the splices. Projecting fibres are pulled out in passing over the pulleys, and so the splice is gradually destroyed. A three-ply Manilla rope is better than four-ply. The ropes, especially when of cotton, which wears very well, should be dressed with beeswax, which prevents fibres from rising and renders the rope waterproof—a most important point. A properly dressed and cared for rope, treated with beeswax and a little blacklead, looks, after a year's work, like a polished bar of black metal, and the inside is as clean and dry as when made. When ropes are used to transmit power out of doors, they must be protected from high winds. At the town of Proctor, in Vermont, where ropes were used largely, nothing but complete protection would prevent disastrous whipping of the ropes in spring and winter. In gales of wind the ropes became quite unmanageable, and work was stopped in the mills driven by them. Cables of raw hide have been used with great success in the transmission of power. In a shipbuilding yard in Europe a 50-ton travelling crane, mounted on a dock 300ft. long, is driven by a raw hide fly-rope 1½in. in diameter. After five years this rope shows no signs of wear. Professor Reuleaux has suggested that a whole mill should be driven by one Manilla rope, endless and going over the whole building. We are not aware that any attempt has ever been made to put the idea into practice.

In a curious old book published in London in 1702, "Mechanic Power or the History of Nature and Art Unveil'd," there is a drawing and description of a rope tramway. Two horizontal grooved wheels are mounted on vertical axes, and an endless rope passed round them. On this rope are suspended buckets or baskets. The description says, "On the rope thus doubled, here and there hang baskets, which must be so far distant from each other that they hinder not one another, and the ends of the pieces must be so placed that power may be applied to levers to turn the wheels about their centres, for so the whole rope, with the baskets hanging upon it, will be turned about successively, wherefore if men keep filling the baskets at one end and unloading them at the other the whole hill will easily be transferred." We have here the rudimentary idea of the wire tramway.

It may be worth while to add to the foregoing a few particulars, for which we are indebted mainly to the "Transactions" of our own Institution of Mechanical Engineers. Apparently a fly-rope was first used in this country in 1863 by Mr. Ramsbottom, for driving cranes at Crewe. These ropes were ⅝in. diameter when new, of cotton, and weighing 1½ oz. per foot. They lasted about eight months, and ran at 5000ft. per minute. The total lengths of the rope were 800ft., 320ft., and 560ft. The grooves in the pulley were V shaped, at an angle of 30 deg. The cord was supported every 12ft. or 14ft. by flat pieces of chilled cast iron. The actual power strain on the rope was about 17 lb., and the ropes were kept tight by a pull of 109 lb. put on by a jockey pulley. Rope gearing is now superseding belting and gearing in cotton mills. It has long been used in South Wales for driving helve hammers in tin-plate mills. The ropes are usually about 5¼in. to 6½in. in circumference, of hemp. The diameter of the pulleys should be at least thirty times that of the rope, and the shafts should not be less than 20ft. apart. A 6½in. rope is about equivalent to a leather belt 4in. wide running at the same speed—3000ft. per minute. Such a rope will transmit 25-horse power. The coefficient of resistance to slipping of a rope in a groove is about four times that of an equivalent belt.

CORRECTION.

45, Lincoln's-inn-fields, W.C., December 1st, 1887.

SIR,—The attention of our client, Mr. William Leonard Grant, Inspector of Nuisances for Sittingbourne, has been called to an article headed, "Sanitary Surveyors and Inspectors of Nuisances," which appeared in your issue of the 25th inst., containing statements of a grossly defamatory nature concerning him. The allegations therein contained are wholly and entirely untrue, and are utterly devoid of any foundation whatever. It is untrue that Mr. Grant was called as a witness by either party to the action referred to in that article, or that he gave any evidence whatever in that action. It is utterly untrue that the judge took occasion to say that his conduct as a public official was disgraceful. From first to last he had nothing whatever to do with the action, nor was he in any way whatever, either directly or indirectly, concerned with or interested in the same.

Your article is calculated to do Mr. Grant great and serious injury in his profession and position of Inspector of Nuisances at Sittingbourne, and it will be for our client to take such steps as he may be advised to clear his character, which has been so wantonly attacked by you. Meanwhile, we must request you to insert this letter in a prominent position in the next issue of your paper.

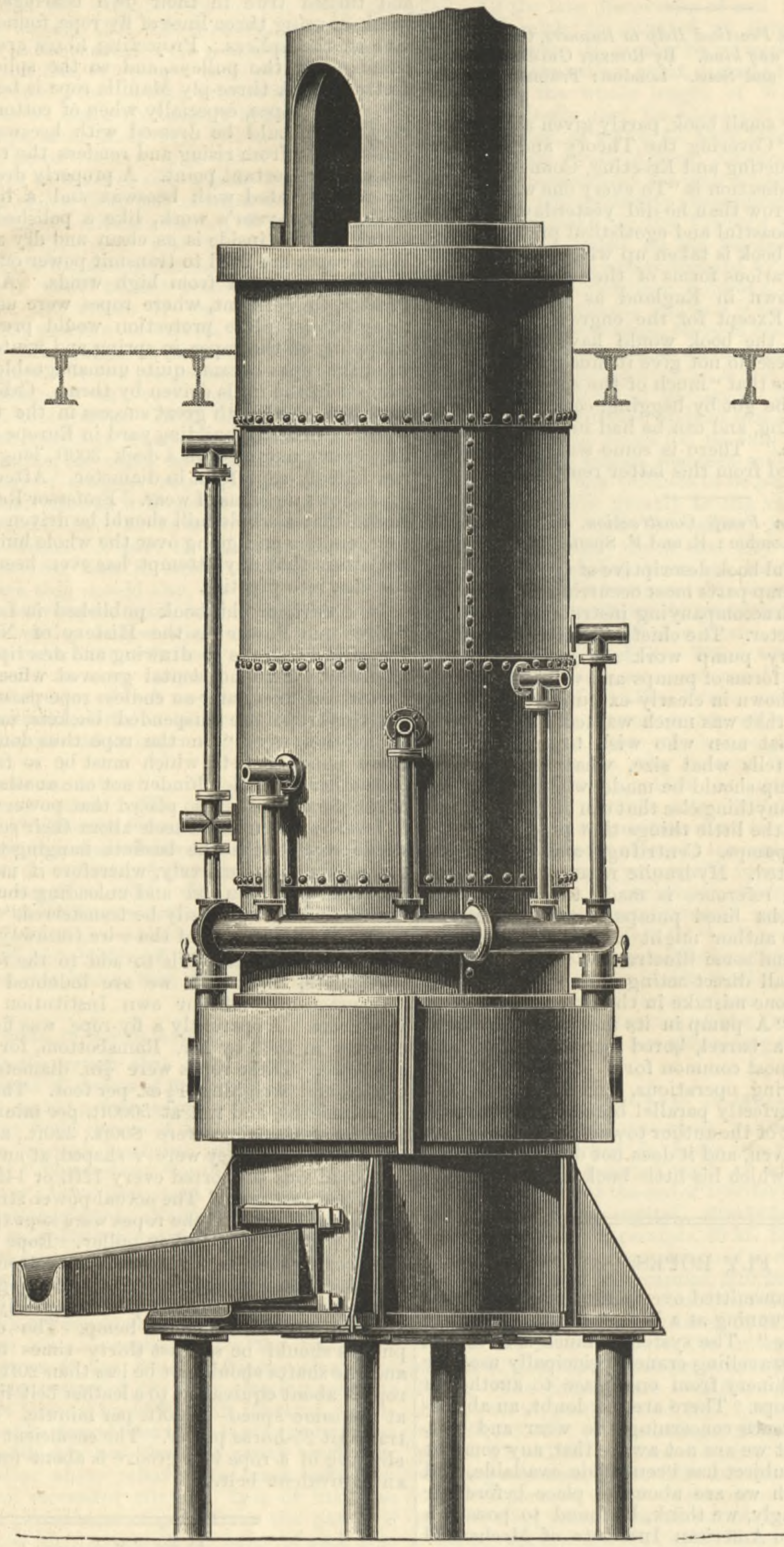
We are, Sir,
Your obedient servants,
BOLTON, ROBBINS, BUSK, AND CO.

To the Editor of THE ENGINEER, 163, Strand, W.C.

[We cheerfully insert the foregoing letter. The mistake arose through an unfortunate substitution, by several of our contemporaries in the reports of the trial, of "Sittingbourne" for Beckenham. The name of the gentleman referred to was not given by us. We very much regret that Mr. Grant should have been thus subjected to annoyance.—ED. E.]

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Warwick Monkhouse, assistant engineer, to the Hero; William W. Pearce and John W. Booth, assistant engineers, to the Thames; and Herbert Coopper, assistant engineer, and A. C. Darley, acting assistant engineer, to the Inflexible. All to date December 5th.

GREINER AND ERPF'S CUPOLA.



GREINER AND ERPF'S CUPOLA.

GREAT improvement has been effected in the design and performance of foundry cupolas during the last twenty years. One cause of loss of heat, however, viz., the escape of unconsumed carbonic oxide, has, until quite recently, practically baffled the ingenuity of inventors. In an ordinary cupola with one set of tuyeres the coke in the combustion zone is burnt to carbonic acid, which, passing upwards through the incandescent layers of fuel immediately above, robs the coke of some of its carbon, and so becomes carbonic oxide. Fig. 1 is a sketch of a cupola with single row of tuyers, the carbonic oxide being formed about the level *a a*. This gas, having little or no air to combine with, rises to the surface of the charge, and meeting the atmosphere, burns, if hot enough, with its characteristic pale blue flame; or, if too cold to ignite, passes invisibly away. A pound of carbon-making carbonic oxide only evolves 4452 British heat units, as against 14,500 units when burnt to carbonic anhydride. It is plain therefore that unless the carbonic oxide is consumed so that its combustion heat can be utilised in raising the temperature of the descending charge, a serious waste of fuel must take place. This has long been understood, and as it is not possible to prevent the formation of carbonic oxide, many attempts have been made to secure its combustion while still in contact with the charge. Obviously the requirement is a supply of air to burn the gas above the point of its formation; and to effect this many cupolas with a double set of tuyeres have been introduced. Among the best known are Ireland's—original patent—and Voisin's. The latter claimed that by his arrangement of tuyeres the gases were burnt in the interior of the cupola, creating a second zone of fusion with the gases alone. Thus the second set of tuyeres obviated to some extent the evil effect of the formation of carbonic oxide. These cupolas were undoubtedly much more economical than many of the older types; but experience has proved this to be due to improvement in shape and proportion of parts, rather than to the utilisation of the carbonic oxide. This view is supported by a consideration of what takes place in cupolas working with two sets of tuyeres placed from 2ft. to 3ft. apart. The carbonic oxide formed above the lower tuyeres is no doubt to some extent oxidised by the supplementary blast, but the coke at this point, being incandescent, is also burnt, with the result that a fresh formation of carbonic oxide occurs, which passes away without doing any duty further than by imparting some of its sensible heat to the descending charge. In fact, the upper tuyeres simply repeat on a smaller scale the action of the lower ones, thus forming a second zone of fusion. Fig. 2 represents a cupola with two rows of tuyeres; the second formation of gas taking place at *b b*. Proof of the general non-efficacy of the double set of tuyeres is afforded by the fact that many cupolas originally constructed with two sets have had their performance improved by the removal of the upper row.

FIG. I.

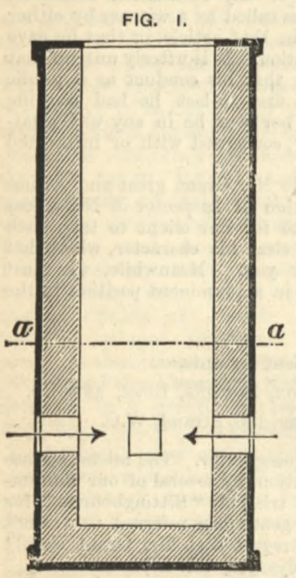


FIG. 2.

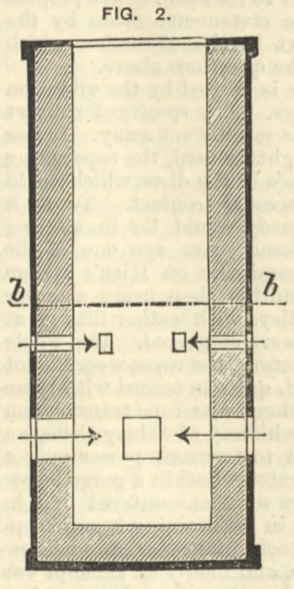
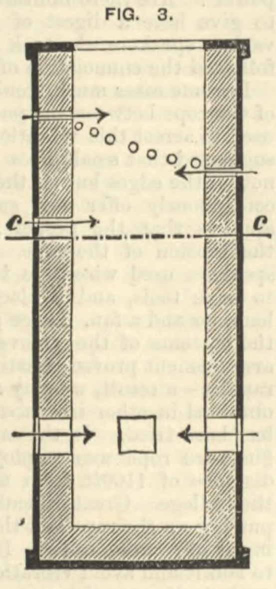


FIG. 3.



Messrs. Greiner and Erpf, in their endeavours to solve the problem of the utilisation of the inevitable carbonic oxide, after careful study of the phenomena attending combustion in cupolas, have made an entirely new departure. They perceived that to effect the required result, the combustion of the carbonic oxide must, according to their descriptive account of the furnace, be commenced at a point so far above the fusion zone that the descending coke has not attained the temperature necessary for ignition; while the ascending combustible gas is still hot enough to ignite on contact with air. Furthermore, the burning of the gas must not take place in one horizontal plane, but must be distributed through some depth of the charge, otherwise the concentration of heat would cause ignition of the coke, and consequent loss. Fig. 3 shows a section of a cupola on this system; the supplementary blast being introduced above the point *c c*, where the fuel has not quite attained the temperature necessary for ignition. The carbonic oxide is thus burnt to carbonic acid, and the descending mass of coke and metal receives the full benefit of the combustion temperature; while owing to the method of distributing and regulating the supplementary blast, the heat at no point is great enough to fire the coke, or to permit of any reaction between it and the carbonic acid. The upper blast is introduced through a number of small tuyeres placed round the cupola in such a way as to secure thorough distribution of the air currents. On the accompanying drawing the small tuyeres are shown disposed spirally round the shell; and this is generally found to be the most convenient arrangement. The invention may be applied to existing cupolas at a small cost, no interior alteration, further than the piercing of the small holes, being required. The additional fittings consist of a circular pipe connected by branches with the blast belt of the cupola; two valves to regulate the pressure of the upper blast; and the small tuyeres with their connecting pipes. The exact size and position of the supplementary tuyeres, and the pressure of blast, vary with the dimensions of the cupola and the conditions of working; and exert an important influence on the degree of economy attending any given application.

The analyses given below, by Messrs. Pattison and Stead, show that this invention effects in a very complete manner the utilisation of the carbonic oxide. The samples were taken from the waste gases just above the charge near the inside lining of two cupolas at the works of the Anderston Foundry Company, Middlesbrough. One of the cupolas was of the ordinary first-class foundry pattern, and the other was a similar cupola altered to Greiner and Erpf's system.

	Ordinary cupola.	Greiner and Erpf's cupola.
Nitrogen, &c... ..	75·50 per cent.	79·92 per cent.
Carbonic oxide ..	11·50 ,,	1·25 ,,
Carbonic acid ..	12·50 ,,	18·75 ,,
Hydrogen	0·50 ,,	0·08 ,,
	100·00	100·00

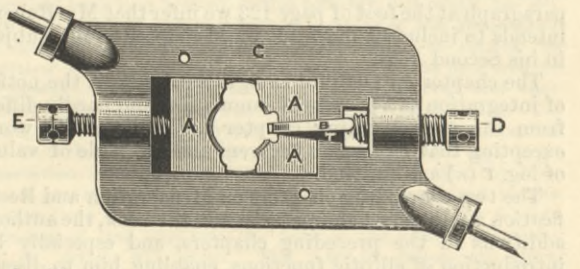
Messrs. Pattison and Stead, in a note on the above, say, "The results show that the heat developed in the cupola, where the gas produced at the main tuyeres is burnt by air injected above, is about 30 per cent. greater than is developed in the ordinary cupola. For many reasons the practical saving of coke in large cupolas will not reach that point, but the results prove beyond doubt that the system is a correct one, and must result in considerable economy of fuel."

These cupolas are in use on the Continent, and in this country their adoption is rapidly extending. Some of the largest ironfounders have already adopted the system, and the agents of the patentees state that in no case where cupolas have been altered on their plan has a smaller saving than 20 per cent. resulted. The average consumption of coke per ton of iron melted, exclusive of the first charge, is given as 90 lb.; and the melted iron is said to be hotter and purer than that from ordinary cupolas. The furnace is being introduced into this country by Messrs. J. P. Hornung and Son, of Middlesbrough.

WOOD'S CHASER STOCKS AND DIES.

THE stocks and dies illustrated by the accompanying engravings are fitted with a chaser tool B, which can be sharpened as required, and it is claimed for it that this secures easy and true screw cutting, specially useful for the larger sizes cut by hand. Fig. 1 shows the under side of the stocks with the die cover and half round guide G, seen in Fig. 2, removed, the guide G and threaded collar F being used for starting a true thread and for guiding the stocks. The little key standing up from the slot in Fig. 2 is for pushing the chaser B—see Fig. 1—into one or other side of the slot T according to the direction of turning the stocks, the chaser cutting both ways. The stocks will face the ends of the pipe, so that when two ends are brought together and tightly screwed on a collar a metallic joint is secured which is suitable for high pressures. These stocks are made by Mr. T. Woods, of Newton Heath.

Fig. 1



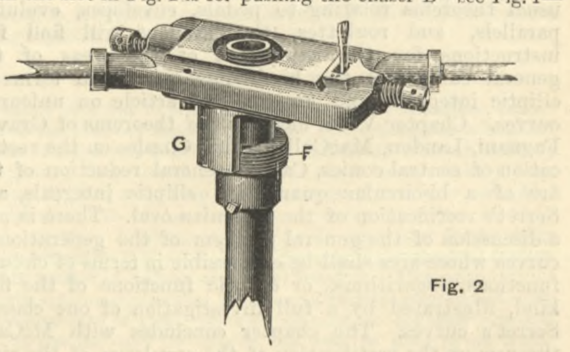
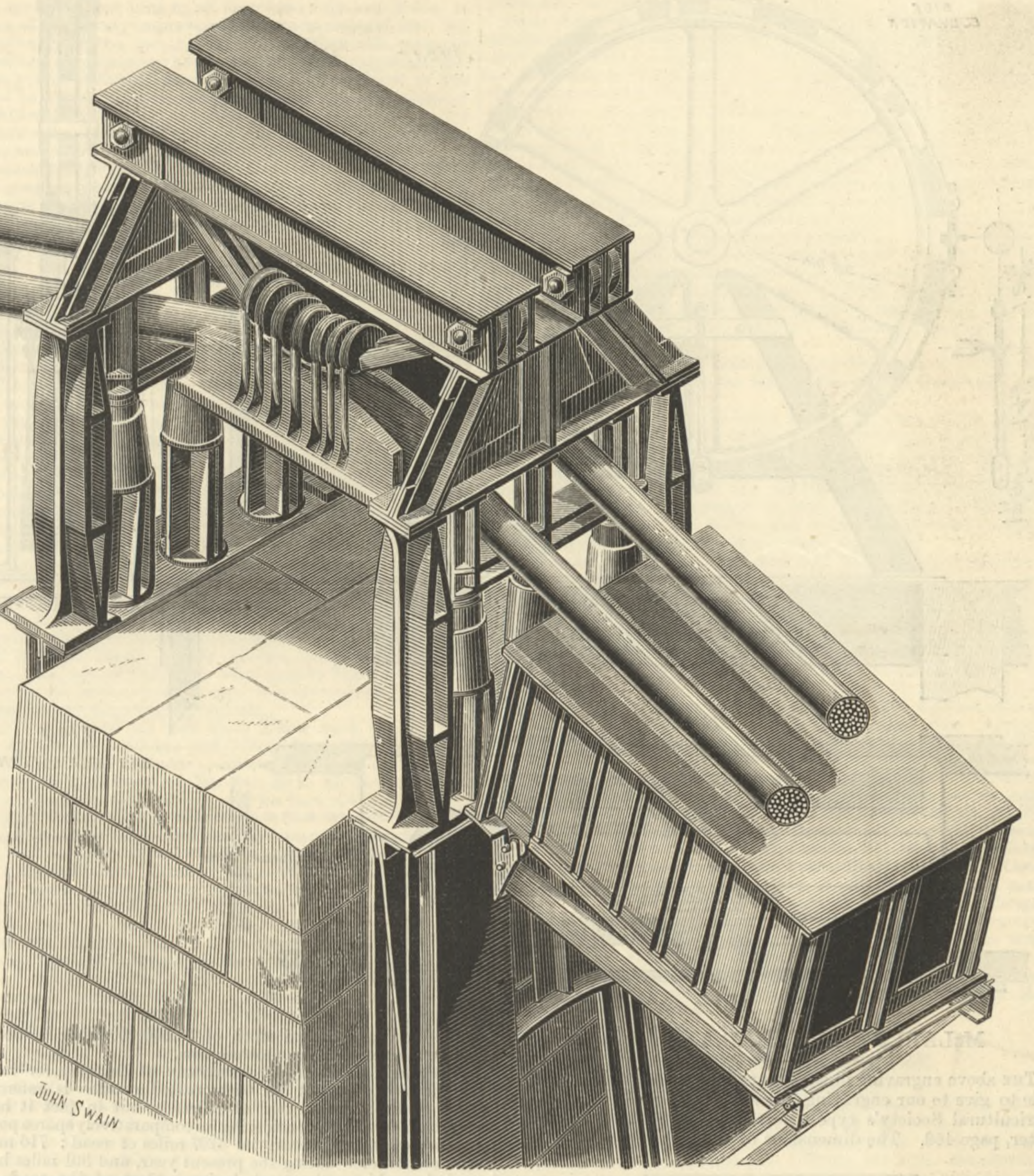


Fig. 2

NEW TOWERS OF THE NIAGARA SUSPENSION BRIDGE.



REPLACING THE TOWERS OF THE NIAGARA SUSPENSION BRIDGE.

AT the meeting of the American Society of Civil Engineers, Nov. 2, Mr. Buck read a paper on the renewal of the towers and the transfer of the cables of the Niagara Suspension Bridge. An abstract follows.

Mr. Buck said in effect that the towers started from heavy bases of rock-faced ashlar, which bases, two on each landing, were connected by an arch under which the wagon road passed. At the level of the trusses the towers were commenced with a base of 15ft. square and were 8ft. square on top.

The towers on the American side were 90ft. high from the rock and 80ft. on the Canadian side, where the rock was higher. The top of each tower was entirely covered by a cast iron bed plate 2¼in. thick, on the upper surface of which were three ribs, parallel to the cables, 2½in. thick by 7½in. high. The two spaces between the ribs were 2ft. 2in. wide and truly planed on the bottom and sides. In each space were ten cast iron rollers turned to a 5in. diameter and 2ft. 1⅝in. long. On each set of rollers rested a saddle of cast iron 5ft. long and 2ft. 1⅝in. wide at the base, planed on the under side, with a U-shaped groove on the upper side, in which the cables rested with an easy curve. Nine holes were cored through the saddle from side to side under the groove.

The stone in the towers and bases was limestone, and soon after completion the masonry of the towers showed signs of failure—most pronounced at about one-third their height—which was due to the bending strains from the elongation and contraction of the cables, which gave a movement of the saddles, amounting to 2in. for temperature, and ⅝in. from live load. Other failures of the masonry were clearly due to weathering. The towers were kept well painted, but the disintegration continued, and Mr. Buck proposed facing the towers with new stone, on the supposition that the masonry in the interior of the tower was sound, which was done in 1883. One tower, faced during the absence of the author in Portland, Oregon, had two serious cracks.

In the mean time motion of the saddles on the rollers had about ceased. All the rollers on the top of one tower only covered an area of 3ft. 4in. by 4ft. 7in. = 17·18ft., the maximum weight being about 900 tons, and in 1885 joints of the new masonry had opened, and cracks were forming in it.

Iron towers were recommended, the plans made, and the work let to the Detroit Bridge and Iron Works. Each iron tower is made up of four wrought iron columns, braced transversely and longitudinally by wrought iron struts and rods. The columns rest on a limestone pedestal capped with granite. The tops of each pair of columns are connected by a heavy web-plate, secured to each web of each column by angles and rivets. These tops are capped by a wrought iron plate planed to a level surface. On the caps of the two pairs of columns rests the built up main bed, 9ft. 2in. long, 5ft. 3in. wide, and 3ft. 8in. high, weighing about 9½ tons. The whole top surface is planed, and on it are laid, but not fastened, two steel plates, with the long sides parallel to the gables, 2ft. 2in. wide, 7ft. long, and ⅝in. thick, with sides and edges planed parallel. On top of this plate are eighteen 4in. steel rollers, of the same length as the width of the plate, the ends of each roller having trunnions entering into holes in the side pieces of the roller frames, which side pieces are planed so as to fit closely to the ends of the rollers and the edges of the steel plates. A cast iron bed 7ft. long, 2ft. 4in. wide, and 18in. high, with top and bottom surfaces planed parallel, and the bottom re-enforced with a planed steel plate, rests on the rollers. The old saddle rests on this. The arrangement is intended to keep out water, and as far as possible dust, the old rollers having been badly rusted. The transverse bracing was put in immediately, but as the longitudinal bracing could not be put in till the masonry was removed, the iron-work was clamped to the stone towers.

The transferring apparatus consisted of four cast iron columns, two transverse and two longitudinal girders, six 125-ton jacks, wrought iron shim plates and No. 8 steel wire. The cast iron columns were set upon the caps, so as to allow the large bed plate to pass between them, the ends of the transverse girders resting on each pair of columns, the two longitudinal girders which rested on them being placed directly over and parallel to each saddle. The saddles were then lashed through the core holes to the bent beams shown in the cut by steel wire. Three jacks were set under each transverse girder, and the new bed plate hoisted and temporarily supported close under the cables.

The six jacks were worked by two men each, and the transverse girders with the load of cables, &c., resting on them were lifted and shimmed up on the cast iron columns. The old bed-plate was then hauled up to the lifting or longitudinal girders, and three courses of masonry removed, and the new bed plate put in position and bolted to the caps; the old bed plate was then lowered and moved on to the supports vacated by the new bed. The steel plates, rollers and saddle beds were then placed in position, the jacks again set up, and the pressure taken off the shims, so that they could be removed and the old saddles settled on their beds. Experience showed that it would have been better if all the jacks had been connected together and worked from an accumulator.

After the preparations for a transfer were completed, the time necessary for making the change, including the removal of the three courses of masonry, and the old bed plate, was 8½ hours; no trains being allowed on the bridge while the transfer was being made. The total weight raised by the six jacks was about 650 tons.

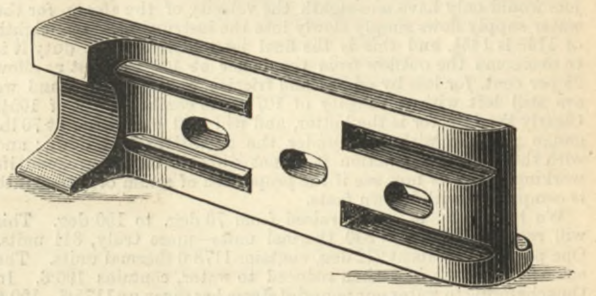
When the second transfer was made the thermometer stood at + 7 deg. Fah. On lifting the saddles from the rollers, the top of the tower suddenly sprang ⅝in. toward the river. As the two Canada towers were found to be leaning toward each other, an effort was made to spread them, and an application of about sixty tons increased the distance between them only ⅝in., which shows that the bending strain was much greater than sixty tons. As the masonry, particularly towards the top of the towers, was much shattered, the author thinks that any successful attempt to keep the towers from bending would have resulted in their prompt destruction by grinding off their tops.—*Railroad Gazette.*

WRITING upon the collisions in the English Channel, and the great traffic through it, a correspondent asks:—"Would not that practicable and not costly scheme, a deep-water lockless canal between the Forth and Clyde, be a great relief even in time of peace, and much more than a relief in time of war? Further, how advantageous for the commerce of London and Liverpool, and of all Ireland! I call attention to this last word. Would any nation but the British have allowed its statesmen so long to leave nature's provision for our security and progress so shamefully neglected?" Who will pay for the canal?

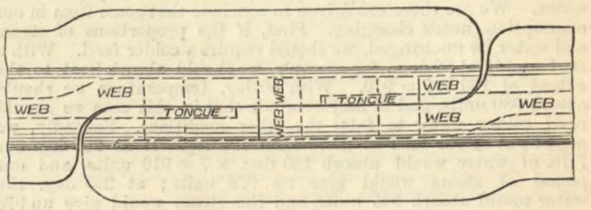
A SPLICED RAIL JOINT.

THE accompanying illustration represents a joint made in the United States under the patents of Mr. Lightfoot. The ends of the rails are formed under dies, and made to fit and interlock with one another, rendering fish-plates unnecessary.

The form of the joint will be best understood by reference to the illustration. Two tongues on one rail fit into two corresponding

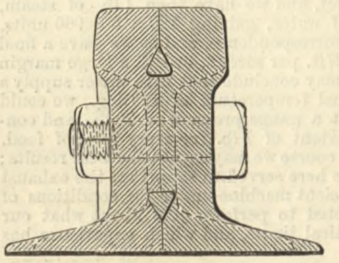


THE SPLICED RAIL JOINT



grooves on the other rail. The three bolts hold the rails together laterally, and the tongues and grooves transfer any vertical movement from one rail to the other.

It is claimed that this joint gives an exceptionally smooth riding track, as there are no projecting rail ends against which the wheels can strike. This would, of course, imply a large reduction of wear and tear both for rails and rolling stock. It will be noticed that at the splice each half of the rail has virtually the full cross sectional area of a rail, and it is therefore believed that the joint will be of ample strength. It is stated that this joint has been in use



with good results under heavy main line traffic near Pittsburg, where some thirty joints have been used for ten months on a sharp curve. The *Railroad Gazette* says the joint as shown in the engraving is about 15in. long. Smaller joints, 12in. long, with only two bolts, have been made, but are not recommended for main line use.

THE EXHAUST INJECTOR.

THE following explanation of the action of an exhaust injector, taken from the columns of the *American Machinist*, will interest many of our readers. The subject will be best understood by taking an actual case and analysing theoretically the action that takes place in an exhaust injector forcing water into a boiler. The exhaust steam may be taken at atmospheric pressure, and the boiler pressure at 70 lb. per square inch above the atmosphere, and the temperature of the feed-water may be assumed at 70 deg. Fah.

The steam temperature corresponding to atmospheric pressure is, of course, 212 deg. Fah.; and we know by practical experience that we can feed water into a boiler at 190 deg. Fah. We will, therefore, take 190 deg. as the feed temperature; that is to say, the rise in temperature of the water is 190 deg. — 70 deg., or 120 deg. Fah. Looking upon the injector as a heat engine, by the laws of thermo-dynamics we should have an efficiency of

$$\frac{t_1 - t_2}{t_1}$$

or

$$\frac{190}{672} = 0{\cdot}28$$

but little over 3 per cent. of the total work in the steam used; but we will not follow out this method of reasoning, but confine ourselves to a plainer statement of the action of the instrument, which can be understood by any who can use the first three rules of arithmetic.

Experiment has shown that steam will flow into a vacuum or into a partial vacuum with a velocity dependent upon the difference between the pressures of the vessels between which the flow takes place. In the exhaust injector we have first steam at 212 deg., which has a pressure of 14·7 lb. per square inch, or say 30in. of mercury. We next have the vessel into which the steam flows. Clearly this is the combining nozzle of the injector at a temperature of 190 deg., equivalent to 19in. of mercury. We will call these two pressures P and p respectively. The density of mercury as compared with water is 13·6 This we will call D. The density of steam at 212 deg. is similarly ·00060826, and this we will call d. Now, careful experiment and reasoning has shown that the rate of flow in feet per second with which steam will pass between two vessels may be expressed by the formula,

$$V = \sqrt{\frac{64{\cdot}4\,[P - p]\,D}{12\,d}},$$

or more simply

$$V = 29{\cdot}6\,\sqrt{\frac{P - p}{12\,d}}.$$

For our particular case, knowing d P and p, we have simply

$$V = 1200\,\sqrt{\frac{P - p}{12}},$$

or 1200 × ·957 = 1148·4ft. per second. This is to say, that if a partial vacuum equal to 11in. of mercury exist in one vessel, steam will rush into it at the speed of 1148ft. per second from a simple open-topped boiler. This velocity is very great, being nearly 800 miles per hour. Here, then, we have our working factor—a jet of steam travelling at 1148ft. per second. This jet becomes condensed by contact with the feed-water, and is so reduced to very small bulk, but still preserves its great velocity. It has now to perform work, having attained this high velocity by a change of temperature—that is, by losing 22 deg. in temperature, it has acquired another kind of energy—the energy of motion—and this it is that must now be utilised to perform work. If we turn to works on hydraulics, we may find that, similarly, to make this investigation short, water issues from an orifice, with a velocity in feet per second

$$= V = 12{\cdot}19\,\sqrt{P},$$

where P is the pressure in pounds per square inch, within the vessel from which the water flows. We will suppose that the boiler pressure in our present case is 70 lb. by the gauge, so that the total difference of pressure between the boiler and the combining cone of the injector is 75 lb. Thus V = 12·19 × 8·66 = 105·5ft. per second, against which the injector has to work. In other words, there is an opening in the boiler out of which water is rushing with a speed of 105½ft. per second; and we require to overcome this jet by means of another jet, which must clearly have a velocity greater than 105½ft., or it will not drive back the issuing jet. It has been stated that, of the water entering the boiler, one-eighth, when forced in by the exhaust injector, consists of the condensed exhaust steam, the remaining seven-eighths being water. This being the case, let us admit that we have a jet of steam at 1148ft. speed, carrying with it seven times its weight in water. Under these circumstances, we should expect that the combined jets would only have one-eighth the velocity of the steam, for the water supply flows simply slowly into the instrument. One-eighth of 1148 is 143½, and this is the final jet velocity, whose duty it is to overcome the outflow from the boiler at 105½ft. Let us allow 25 per cent. for loss by eddies and friction in the nozzles, and we are still left with a velocity of 107½ft. to combat a jet of 105½. Clearly the injector is the better, and will feed our boiler at 70 lb. gauge pressure with ease under the conditions laid down; and with this view of its action it is not difficult to comprehend its working. Let us now see if the proportion of steam of one-eighth is compatible with known facts.

We have 7 lb. of water raised from 70 deg. to 190 deg. This will require $120 \times 7 = 840$ thermal units—more truly, 844 units. One pound of steam at 212 deg. contains 1178·6 thermal units. The same at 190 deg., *i.e.*, when reduced to water, contains 190·6. In thus changing to water our pound of steam has given up $1178·6 - 190·6 = 988$ thermal units, but we have only absorbed 844 by our 7 lb. of water. We are therefore driven to conclude that some item in our assumptions needs changing. First, if the proportions of steam and water be unchanged, we should require a colder feed. With a feed supply of 60 deg., for example, we should absorb heat to the extent of $130 \times 7 = 910$. With 50 deg. temperature we should absorb 980 units, and so may conclude that in this case we should need colder water to fulfil the other conditions. Secondly, we might put in our feed at more than 190 deg. If at 200 deg. our 7 lb. of water would absorb 130 deg. $\times 7 = 910$ units, and our pound of steam would give up 978 units; at 205 deg. the water would absorb 945 units, and the steam would give up 973 units; but at 205 deg. the rapidity of steam flow would be much reduced, being only 600ft. per second by the formula given above. So we may conclude that the injector would not work in this second case at all.

Finally we may suppose the amount of steam consumed to be only one-ninth of the total jet, and we have then 1 lb. of steam, losing 988 units and 9 lb. of water, gaining $120 \times 8 = 960$ units. Here we have a very close correspondence, and as we have a final jet velocity of $1148 \div 9 = 127$ft. per second, or still a large margin for frictional resistance, we may conclude that with water supply a little under 70 deg. and a final temperature of 190 deg., we could feed readily into a boiler at a gauge pressure of 70 lb., and consume exhaust steam to the extent of 1 lb. for every 9 lb. of feed. With colder water supply of course we may expect the best results; but a few simple figures have here served to show that the exhaust injector is a remarkably efficient machine under its conditions of working, and may be expected to perform just about what our figures show to be its practical limits, and which experience has proved are such.

LAUNCHES AND TRIAL TRIPS.

Messrs. Simons and Co., of Renfrew, have received instructions to construct a first-class steel screw steamer, of 1000 tons, for an East Coast firm. The vessel is to be built under Lloyd's special survey to Class 100 A1, and is to be fitted with triple expansion engines, which will be supplied by the builders.

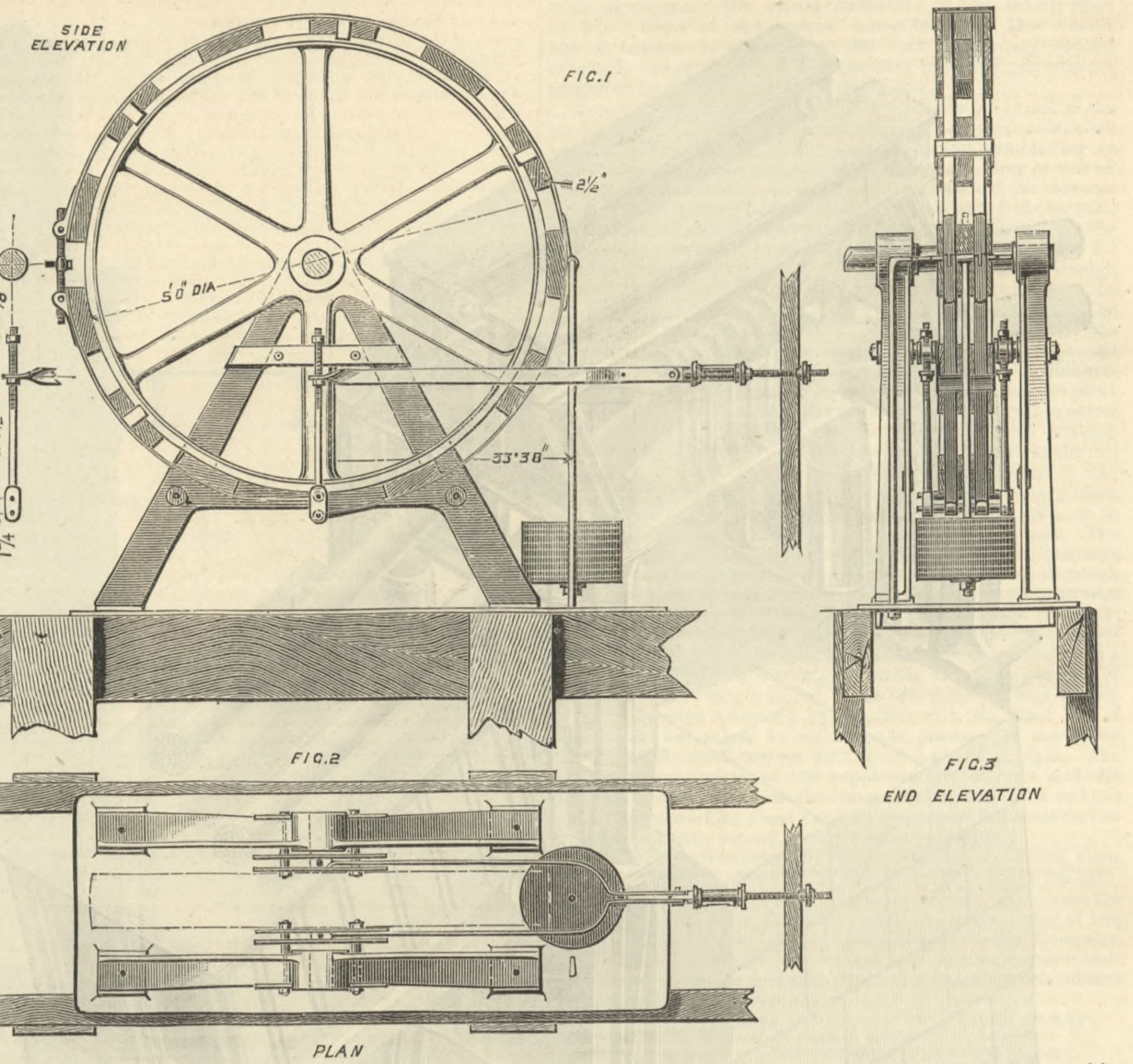
Trial trip ss. Oakwell, 125ft. by 22ft. by 11ft. 1in., built by Messrs. Craig, Taylor and Co., of Stockton, for coasting trade, and about to be worked by themselves, was taken to the measured mile at Whitby on Saturday, and had a very satisfactory trial trip, a mean speed of nine knots being obtained. The engines are supplied by Messrs. Westgarth, English and Co., of Middlesbrough, and are 50 nominal horse-power, having cylinders 18in. and 36in. by 24in., and gave entire satisfaction during the trial.

The new steel screw steamer Kate B. Jones, built by Messrs. Schlesinger, Davis and Co., of Wallsend-on-Tyne, for Messrs. Jones and Thomas, of Cardiff, left the river this week laden with a cargo of about 2800 tons bound for Genoa. This vessel has been built to the highest class at Lloyd's, and has scantlings in excess of their requirements. Her dimensions are as follows:—Length over all, 279ft.; length between perpendiculars, 270ft.; breadth moulded, 37ft.; depth moulded, 21ft. 8in. She is constructed on the cellular bottom principle for water ballast throughout all her holds, and has a long raised quarter-deck, surmounted by a short full poop. All parts of the ship are lighted throughout with the electric light in addition to the ordinary ship's lamps. Under the flying bridge amidships two light towers have been built in which are placed the side lights, which are so arranged that the ordinary lights or the electric light may be used. The engines have been built by the North-Eastern Marine Engineering Company, Wallsend-on-Tyne, and are of about 180 nominal horse-power. All the latest improvements have been concentrated on these engines, which during the trial worked smoothly and well, and developed about 1000-horse power effective, and the speed was, we are informed, an average of 9½ knots without pressing the vessel in any way.

On Monday last Messrs. Russell and Co. launched from their Greenock yard a large steel screw steamer, the Chester, for the petroleum bulk carrying trade between America and the Continent. This vessel is 310ft. long, 39ft. beam, and 25ft. depth, and is capable of carrying about 3500 tons of oil. The vessel is divided into sixteen oil-tight compartments exclusive of the water ballast tanks, and from the peculiar nature of the cargo to be carried, great care has been taken with the workmanship throughout, and the tanks have been subjected to exceptionally severe tests before launching, which they stood very satisfactorily. The vessel will be lighted throughout by electricity, and is fitted with a powerful set of Worthington pumps capable of discharging the entire cargo in about twenty-four hours. Triple expansion engines will be supplied by Messrs. Duncan, Stewart and Co., of Glasgow, the cylinders being 22in., 36in., and 58in., with a stroke of 42in. There are two large single-ended boilers, the working pressure being 160 lb. This is the first vessel of the kind, we believe, that has yet been built on the Clyde, and with her sister ship now on the stocks in the same yard, have been built to the order of Messrs. Hermann Stursberg and Co., of New York, from the plans and specifications of Messrs. Flannery and Blakeston, consulting engineers, of Water-street, Liverpool, who have also superintended the vessels during construction. Mr. F. W. Randebrock, of New York, and Mr. Horstmann, of Rotterdam, represented the owners at the launch, and the christening ceremony was gracefully performed by Mrs. Randebrock, who named the vessel the Chester. The Chester will be commanded by Captain L. Wohlmuth, late of the North German Lloyd's. The sister vessel will be launched in about a month.

On the 19th ult., Messrs. Oswald, Mordaunt, and Co. launched a fine iron screw steamer, the Saxon, built for the Union Steamship Company, and intended for their intercolonial service. The principal dimensions are—length, 154ft.; breadth, 24ft. 8in.; depth, 16ft. 8in. The vessel is built to class 100A Lloyd's, and has accommodation for seventeen first-class passengers aft, with large deckhouse, forming entrance to saloon. Accommodation is also provided for thirty second-class passengers forward of engine and boiler space. Captain and officers' berths are under the bridge deck, and the crew and firemen under main deck forward. She has two steam winches for working cargo, steam windlass and crane for working anchors, Alley and McLellan's sentinel steam steering gear on bridge, and hand gear aft. The engines and boiler were also built by Oswald, Mordaunt, and Co., having cylinders 14in., 23in., and 38in. diameters, and 27in. stroke. One single-ended steel boiler constructed for a working pressure of 160 lb. per square inch.

McLAREN'S BRAKE, R.A.S.E. TYPE.



McLAREN'S BRAKE, R.A.S.E. TYPE.

The above engraving illustrates to a larger scale than we were able to give to our engraving last week, the brake of the Royal Agricultural Society's type referred to in Messrs. McLaren's letter, page 460. The dimensions of the parts are fully given.

AMERICAN ENGINEERING NEWS.

(*From a Correspondent.*)

Coast defences.—The annual report of General Duane, chief of engineers, to the Secretary of War, devotes considerable space to a statement of the condition of sea coast and lake front defences. Many of the works are dilapidated, and economy requires that they should be kept from decay. The estimates submitted aggregate 5,234,000 dols., including 2,840,000 dols. for the construction of gun and mortar batteries, 175,000 dols. for the preservation and repair of fortifications, 1,860,000 dols. for submarine mines and appliances for closing channels, and 30,000 dols. for torpedo experiments. No iron armour is estimated for, because more extended defences can be obtained by investing the funds in such needed works as mortar batteries disappearing gun batteries, and works connected with submarine mines. The Board of Fortifications has prepared designs for fortifications, to meet modern conditions, constructed of sand, covering the masonry and bomb-proof. The plan of defence by mortar and gun batteries recommended by the Board involves an expenditure of about 2,840,000 dols. during the next fiscal year.

A new Nevada Railroad.—A line of railroad is now projected between Salt Lake City, Utah, and Los Angeles, Cal., a distance of about 650 miles. The road will be standard gauge, and it is understood to be an independent affair, not allied with the Denver and Rio Grande Railroad, the Union Pacific Railroad, or the Utah Central Railroad; the maximum grade is said to be 60ft. per mile. From Salt Lake City the line will run south-west through a pass in the Snake range to White Pine County, Nev., and south through Nye County to the great Nevada plateau; it will probably touch at Los Vegas in Southern Nevada, and will follow the valley of the Colorado river for some distance. The route will cross the Mojave desert to the San Fernando range, which it will cross by the old stage road to San Bernardino, from which there is an easy route to Pasadena and Los Angeles. The line will have a route between Los Angeles and Chicago several hundred miles shorter than the Atchison, Topeka, and Santa Fé system. The widest stretch of desert on the route is said to be thirty-five miles, and a rich mineral region is expected to be developed.

The Quaker Bridge dam.—There seems to be some little misapprehension abroad with regard to this proposed stupendous work, which is to secure for New York City an ample water supply for many years to come. Beyond the preparation of the section and of general preliminary plans and estimates, very little has been done; and although its construction has been finally decided upon, after a very lengthy and heated discussion, yet no steps have as yet been taken towards letting contracts and starting the work. As the New Croton Aqueduct is now so far advanced, it is probable that the dam question will very shortly be taken up practically. The recent report issued by the Commissioners did not refer at any length to the dam. The distribution of this report has been criticised very adversely, as it has been given away to many politicians and others who have no use for it, while several engineers have had a difficulty in securing a copy. The chief engineer had no hand in the distribution, but applications to him were referred to the Commissioners' committee on distribution.

A big stockyard scheme.—Mr. A. H. Stickney, president of the Minnesota and North-Western Railroad Company, is at the head of two enterprises of great importance to Chicago. The Chicago Stockyards Company has been incorporated with a capital stock of 10,500,000 dols., for the purpose of establishing railroads and yards for cattle and other live stock, and to lease yards and packing-houses. The other company, which is intimately connected with the above, is the Chicago Transfer Railway Company, capital stock 2,000,000 dols., which will inaugurate a system of transferring cars of all the various railroads centreing in Chicago, at an expense much below the present cost. The present Union Stockyards Co., which has a capital stock of 13,000,000 dols., is interested in and connected with the new projects.

Railroads in Dakota.—The territory of Dakota—for in spite of its agitation it has not yet been created a state—is generally supposed to be almost devoid of railroads, but in fact it has a very respectable mileage, considering its comparatively sparse population. The present systems comprise 4207 miles of road; 716 miles have been constructed during the present year, and 301 miles have been graded ready for the track laying. Most of the roads are controlled by the trunk line companies, but a few short roads have been built to and in the mining districts principally. The railroad system is gradually spreading to the west and northwest sections of the territory.

The fate of an old canal.—The Union Canal, in Pennsylvania, the first canal projected in America, having been suggested by William Penn in 1690, and surveyed seventy years later, before any canal was in operation in England, is to be sold. The route was surveyed by David Rittenhouse, the astronomer, and William Smith, Provost of the University of Pennsylvania, in 1762. It extended from the Schuylkill river, near Reading, Pa., to the Susquehanna at what is now Middletown, and was the first link of a proposed chain of water communication between the Delaware river and Lake Erie, a gigantic project for those days, which caused the projectors to be thought crazy. Work was interrupted by the Revolutionary War, and though it was started up again in 1791 by Robert Fulton and others, they were in advance of their day, and it was only completed in 1827. The canal is eighty-nine miles long, and on it was the first tunnel in America, about 800ft. through rock. The summit being higher than the feeder at the end, pumping plant had to be put in to raise the water. The total cost was 5,000,000 dols. The reason of its sale is that the railroads have made its operation unprofitable.

Railroads.—The city of Helena, Mont., has celebrated the completion of the Montana Central Railroad, and the St. Paul, Minneapolis, and Manitoba Railroad. The construction of the latter was a remarkable piece of art—as shown elsewhere by an extract from an American paper. The San Joaquin Valley Railroad, now under construction, in the interest of the Atchison, Topeka, and Santa Fé Railroad, will give the latter a line to San Francisco in competition with the Southern Pacific Railroad. In Mexico a narrow gauge road is projected from Patzcuaro, on the Mexican National, to the Pacific Coast, at a point in the State of Guerro. The capital will probably be raised in the United States.

Sugar from sorghum.—The experiments on the production of sugar from sorghum by a new process, which have been in progress at Magnolia plantation, Louisiana, have had very satisfactory results. The roller process which was in use some years ago, only pressed out about 40 lb. of sugar per ton of cane, while the cane contained three times that amount. By the new "diffusion" or "saturation" process about 140 lb. have been obtained, equalling 98 per cent. of the sugar in the cane. The Commissioner of Agriculture thinks that in a few years America will make all the sugar required for home consumption. Sorghum can be grown as far north as Michigan.

Brooklyn's elevated railroads.—In Brooklyn, N.Y., the construction of the new lines of elevated road is in rapid progress. The King's County Elevated Railroad has "Phœnix" columns on the curb line, with rivetted trusses across the street, and three—in some places four—longitudinal girders, the track being over the middle of the street in accordance with the terms of the purchase. The Union Elevated Railroad has square columns—channels and plates—in the street, just clear of the street railroad tracks, with plate cross girder and four longitudinal plate girders. The existing Brooklyn Elevated Railroad is not extending its system. All are deck structures. The two former lines will connect with the New York and Brooklyn Bridge, but whether through cars will be run is a moot question.

Heavier rails.—There is now an active movement in favour of heavier steel rails for railroads. The use of sections far too light for the traffic has been the cause of innumerable accidents, and has added to the English prejudice against this form of rail. Rails weighing from 56 lb. to 60 lb. per yard have been quite common. Several Southern roads are now laying 64 lb. and 67 lb. rails, but this is only a step towards still heavier. The New York Central and Hudson River Railroad is laying an 80 lb. rail, and the Pennsylvania Railroad is experimenting with a 90 lb. rail. Probably the standard rail of the near future is a 100 lb. rail, as recommended by Mr. Sandberg.

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

(*From our own Correspondent.*)

THERE is a more buoyant tone in all branches of the iron trade, in consequence of the steady improvement in crude material and the combined advance in the metal market. Whether this stronger tendency will be as evanescent as the revival which appeared last year cannot yet be definitely expressed. But the chances of the trade would be certainly more favourable were the improvement to have resulted from a larger consumption of finished iron. For pigs and some other classes of iron consumers are freely inquiring, and makers are confident in their anticipation of a further augmented business being experienced with the advent of the New Year.

The one question which overshadows all others this week in iron trade circles is the proposed tariff reduction in the United States. Ironmasters in this district have read President Cleveland's message with exceeding interest. On 'Change, in Birmingham, this afternoon, the probabilities were the main subject of discussion among the leading ironmasters. A reduction in the tariff would be certain to increase the American demand from this country, though there were far-seeing men who declared this afternoon that the importation of raw materials free of duty into the States would lead to increased competition from America in our export markets.

Meantime the President's proposal makes for an improvement in the tone of the iron market here, and prospects are considered to have been sensibly brightened by the message.

Among the orders which are being executed in this district, at present for the United States, are contracts for steel bars, wide steel strips, &c. Certain of the bar orders are being rolled from locally smelted steel, while the strips, varying from 6in. to 13in. sizes, are being rolled from imported Welsh blooms.

The demand for steel is increasing weekly, and the supply is augmenting proportionately. The former tone of the hematite market has not yet much influenced prices of steel, though some sellers are asking more, and some makers at a distance are independent in the matter of accepting orders from customers in this district unless they are for good quantities. This arises from the large demand which most of the great steel works in other parts of the kingdom are experiencing on the spot for heavy sections of steel, such as nails, plates, ingots, blooms, &c. Certain of the Welsh steel firms, whose deliveries were greatly retarded during the summer by the serious drought, are, it is understood here, now making great efforts to get up the lee-way.

Bessemer blooms and tin bars from Wales were quoted this afternoon £4 17s. 6d.; blooms and billets from the West coast, £4 12s. 6d. to £4 15s.; Siemens qualities, £4 15s. to £4 17s. 6d.; tin bars from the West coast of 7in. size, £5 to £5 2s. 6d.; Bessemer blooms from Scotland, £4 15s.; and tin bars, £4 17s. 6d.

It is in pigs rather than in finished iron that interest is at the moment centred, since it is the steadily improving tendency of crude iron that is regulating all other branches of the trade. Here and there some excitement exists among consumers. The situation is becoming more favourable to the vendors, whose action is at present adverse to the transaction of business. It speaks well for the probable maintenance of better prices that they are practically standing off the market, in spite of favourable terms offered by consumers for forward business. Some makers of Midland brands, indeed, have wholly withdrawn their quotations.

The advance of from 1s. 6d. to 2s. per ton on second-class imported brands is well maintained. Northamptons are quoted 38s. upwards, delivered to works, and Derbyshires, 38s. to 39s. 6d. For special brands of Northamptons as much as 39s. to 40s. is asked. Lord Granville's grey forge pigs are quoted 39s. 6d., delivered here, and No. 1, 47s. 6d. Some of the South Staffordshire second and third-class makers stood off the market, except at a full 1s. 6d. advance demanded a week ago.

A considerable firmness still characterises the hematite market, sellers urging their inability to make concessions owing to the increase in the cost of manufacture. This results from the advance of 2s. per ton. in freights from Spain, and from the prices of ore having gone up from 3d. to 6d. per ton. The sequence is that makers' charges have virtually risen from 4s. to 5s. per ton on the hematites produced. West coast hematites this week quoted strong at 53s. to 54s. 6d. for forge sorts delivered, and Welsh hematites, 52s. 6d. delivered.

Orders for bars are a little more plentiful, and makers of best and common sorts are in receipt of increased shipping enquiries. India, China, and other Eastern markets are expressing better requirements. This was the report this—Thursday—of, amongst other firms, Mr. B. Hingley, M.P., chairman of the Ironmasters' Association. Australian demand is also slightly improving; prices keep at £7 for best; £6 for second branded qualities; and £4 17s. 6d. to £5 for common. Messrs. Jno. Bagnall and Sons have just secured new contracts for strips and bars, representing a considerable aggregate, and they are now holding off for better prices.

There is every indication of the present heavy demand for black sheets being sustained. Orders are being worked to the full capacity of the plants, and these are followed by other business, which is providing employment for some months ahead. The galvanisers are still contributing the largest proportion of this demand, but the merchants are also important buyers, and are taking better quantities for Russia, India, Australia, and other countries. Prices are well maintained, they being now from 10s. to 12s. 6d. above those of some months ago. Singles, which at that time were £5 15s., are £6 5s.; doubles, which were selling at £5 17s. 6d. to £6, are now £6 10s.; and lattens are £7 7s. 6d. to £7 10s.

There is no decline in the excellent demand which the galvanisers have of late been experiencing. Complaints, however, are made by leading makers of the underselling which exists. Considering that spelter has now risen to £18 10s. from a minimum of something over £14, much better prices should be ruling for galvanised sheets. Prices are this week quoted £11 to £11 5s. per ton for 24 g. bundled, delivered Liverpool.

I regret to find that the statement in my previous reports as to the probability of Messrs. J. Lysaght erecting a black sheet works at Bristol, to supplement their Wolverhampton output, was an error. Messrs. Lysaght have pointed out the inaccuracy, and I gladly make this correction.

A meeting of ironmasters, representing Staffordshire, Shropshire, South Yorkshire, Derbyshire, and Lancashire, was held today at the Queen's Hotel, Birmingham, to consider the maintenance of the Wages Board. It was resolved to continue to support the Board, which was instructed to revise its constitution. Mr. B. Hingley, M.P., chairman of the Ironmasters' Association, announced an improvement in trade, and appealed to the meeting to lessen competition, and as far as possible stiffen prices.

Cokes and ironstones are rather stronger in price. Some Yorkshire and Durham cokes have advanced 6d. to 9d. per ton.

At a meeting of the South Staffordshire Mines Drainage Commissioners in Wolverhampton on Wednesday, a motion was passed unanimously on the proposition of Mr. C. Tylden Wright, the agent of the Earl of Dudley, rescinding a former resolution of the Board to apply to Parliament for additional powers. The governing body of the Commissioners did not oppose the motion, having previously intimated their intention of abandoning for the present their original proposition to go to Parliament. Mr. E. Terry, the mining engineer to the Tipton district, reported the exceedingly gratifying intelligence that the great Bradley pumping engine, which has been stopped for fifteen weeks through serious breakdown, has now been restarted. The secretary of the Board, Mr. Hy. Smith, resigned his position from advancing years, and the resignation was accepted with regret.

During this week Messrs. J. and L. Lea and Son, 19, Cannon-street, Birmingham, have sold by auction 1300 tons of plant, erections, &c., at Lea Brook Ironworks, Wednesbury. The following are some of the prices realised per ton:—Good cast iron floor plates, £4 1s. 8d.; hammered iron, £3 11s. 8d.; puddled bars, £3 18s. 4d.; mill and forge tools, £2 13s. 4d.; smiths' tools, £4 10s.; puddlers' bushes, £1 15s.; tap wagons, £2 13s. 4d.; wrought scrap, £2 11s. 8d.; cast scrap, £1 13s. 4d. The twenty-seven puddling and annealing furnaces sold, to be pulled down, at about £1 10s. per ton. These prices may be considered very satisfactory.

Some of the shareholders in the wagon-building concerns of Birmingham and the neighbourhood are dissatisfied with the system upon which they are managed. They assert that the companies are practically in the hands of the managers, whose interests in the matter of competition for contracts are not always those of the proprietors. It is stated that attempts will be made to form a Wagon Companies Shareholders' Association, which will endeavour to bring about either an amalgamation or a trading arrangement.

The further advance of £5 per ton announced this week in copper, making a total rise of £25 or £26, and continued advances in tin, which are now beginning to be followed by an advance in the lead market, are resulting in further increases in the hardware prices of the Birmingham and Wolverhampton district. All the cast iron hollowware firms of the kingdom have announced a second reduction in the discount of tinned hollowware of 2½ per cent., making the present discount 50 per cent.; and a third advance is likely. Galvanised hollowware goods are advanced by some of the makers by a 5 per cent. reduction in discount. Other advances are also announced.

Messrs. Nettlefold have declared an interim dividend for the six months ending 30th September last, at the rate of 5 per cent. per annum.

Considerable opposition is being shown by some of the Black Country towns to the goods traffic on the tramways as carried on by the South Staffordshire Tramway Company. The company are running goods through West Bromwich, notwithstanding that the consent of the Town Council has not been obtained, and on Wednesday the council determined to give the company a month's notice to discontinue the traffic, and failing compliance, to apply to the High Court of Justice for a restraining order.

On Tuesday the new machinery at the Wednesbury sewage outfall works was formally started. To prevent the pollution of the river Tame the authorities have adopted a partially separate sewage system, the storm water being separated from the sewage. All floating matters will be removed from the sewage, and the sewage itself will be treated by chemicals in eight tanks, each of 50,000 gallons capacity. The sludge deposited in the tanks will be taken through tanks to the compressors near the engine-house. There are two 40 indicated horse-power Otto gas engines, having direct-acting air compressors for raising the sewage with. Shone's ejectors, from the low-level to the high-level sewers, and the engines also operate upon Westinghouse air compressors, and a vacuum pump for sludge pressing. The gas generators—which make Dowson's economic gas—the gas engines, and the air compressors are all in duplicate. There are two of Messrs. S. H. Johnson and Co.'s sludge filtering presses, each capable of pressing 15 tons of sludge per day. The works will be fed by twenty-seven miles of sewers, of which the Patent Shaft and Axletree Company has supplied the cast iron pipes, as well as the special castings. The Glenfield Company, Kilmarnock, have supplied the gas engines and the other machinery, whilst the general constructive work has been done by Mr. G. Law, Kidderminster. The total amount of the loans for sewerage purposes is £45,000, which is not likely to be all expended. The resident engineer has been Mr. C. Richards, of Coventry, and the consulting engineer Mr. E. Pritchard.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Although there is perhaps rather a falling off in the weight of buying, as compared with what was doing a week or so back, the stronger tone which I reported in the iron market last week is more than maintained. There are still considerable inquiries in the market, and the continued upward movement in Glasgow and Middlesbrough warrants necessarily tends to strengthen prices here, which, notwithstanding that makers are mostly asking advances of quite 6d. to 1s. per ton upon late rates, are still low. Many of the large buyers are already well covered, and this, of course, tends to restrict the volume of possible business; but the transactions which are still being put through represent a a fair weight of actual business doing. Buyers, of course, do not care about paying advanced prices when there is no apparent real improvement in trade to warrant an upward movement; but although this is regarded as largely due to speculation, they recognise the fact I have already pointed out that prices are still low, and that there is still a margin for further advance before they can be said to have got to a remunerative point for makers. There is therefore not only the possibility that the present slight recovery from the excessively low rates that have recently been current may be maintained, but that with any slight improvement in general trade there may be a further upward move. Merchants and consumers are consequently showing a disposition to buy in larger quantities than they otherwise would have done, not because there is any materially increased weight of iron at present going into actual consumption, but rather as a matter of precaution to place themselves in a safe position in the event of any further possible advance. In other words, in the place of buying simply from hand-to-mouth, which until recently has been the policy naturally pursued in a falling market, merchants and consumers have been buying in large quantities beyond their actual requirements for as far forward into next year as possible. Whether all this heavy buying will be followed by a reaction in the market, or lead up to a better state of trade, remains to be seen; for the present it has been productive of a decidedly healthier tone. Hematites are also decidedly firmer, but the business doing in this market is only small. There has also during the past week been a strong upward movement in steel plates, due mainly to large orders having been placed on the Clyde, partly on American account and partly as the result of increased activity in shipbuilding, and prices have gone up quite 10s. per ton on recent current rates. Manufactured iron remains without material change, as, although forges are mostly kept fully occupied with the orders in hand, there is no weight of work ahead, and makers are not more than able to maintain their position, with the prospects for the future rather doubtful.

There was a full average attendance on the Manchester iron market on Tuesday, and a strong tone prevailed generally. For pig iron there was a fairly active inquiry, and for district and outside brands higher prices were being asked. Quotations for Lancashire pig iron remained at about 38s. 6d. to 39s. 6d., less 2½, for forge and foundry, delivered equal to Manchester; but as these figures are still considerably above the prices at which Lincolnshire iron can be bought, local makers have not so far participated to any appreciable extent in the increased weight of business that has been doing, although they report more inquiry. For foundry qualities of Lincolnshire and Derbyshire makers are asking fully 1s. per ton above the prices they were taking last week, 38s. being now the minimum for Lincolnshire, and 41s. for Derbyshire foundry, less 2½, delivered equal to Manchester, and at about these figures there has been a moderate business done. For forge qualities, however, there is only a limited inquiry, and the buyers who are in the market hesitate about paying any advance; Lincolnshire makers are asking about 6d. over recent minimum rates, and the average quotation is now about 36s. 6d., less 2½, delivered here. Outside brands offering in this market are also higher in price. For Scotch iron sellers are now generally firm on the basis of makers' list-rates, which for some time past have been considerably above the prices taken in the open market, and for good named foundry brands of Middlesbrough makers are holding to about 41s. and 41s. 6d., net cash, as the minimum for delivery equal to Manchester. Good qualities of No. 3 foundry hematite are now generally quoted at 52s. 6d., less 2½, as the minimum for delivery in the Manchester district, but there is not much actual business doing in this market to really test prices. For steel plates local makers are now firm at £7 5s. for delivery in the Manchester district, and some fair orders have been booked at this figure, whilst some of the better qualities of Scotch plates could not be got at anything under £7 7s. 6d., delivered here. In finished iron the actual business offering in the market, except in sheets, is not large, and prices remain at about £4 12s. 6d. for bars, £5 5s. for hoops, £6 10s. for ordinary qualities of sheets, and £6 12s. 6d. to £6 15s. for the better qualities for galvanising purposes delivered in the Manchester district.

The condition of the engineering trades remains without improvement. Generally throughout this district works are kept not more than moderately employed on orders which have to be taken at very low prices. There are, of course, some few exceptions, but these are mostly where there is some special class of work. The returns of the trades' union societies are still discouraging as to the immediate prospects of trade in this district, and apart from the number of men who have been taken off their books by the termination of the Bolton strike, there is no appreciable reduction in the high percentage of members who are receiving out-of-work support.

A very quiet tone continues throughout the coal trade of this district. Collieries are working considerably under their full average output, yet supplies of all descriptions of fuel are plentiful in the market. House fire coals are only in very moderate demand for the season of the year. Common round coals for steam and ironmaking purposes, and engine classes of fuel, continue generally in poor demand, with inferior sorts quite a drug in the market. Prices, which remain, with few exceptions, practically at about summer rates, average 9s. for best coals, 7s. to 7s. 6d. seconds, 5s. 6d. to 6s. common house coal, 5s. to 5s. 6d. steam and forge coal, 4s. 6d. up to 5s. for the better qualities of burgy, 3s. 6d. up to 4s. for best slack, and 2s. 6d. to 2s. 9d. for common sorts at the pit mouth.

There has been rather more doing for shipment, but trade is still only quiet, and there are excessive supplies which keep prices very low, good ordinary steam coal, delivered at the high level, Liverpool, or the Garston Dock, being obtainable at 6s. 6d. to 6s. 9d. per ton.

Barrow.—There is further improvement to note in the hematite pig iron trade of the district, and the demand from all sources has improved to such an extent that prices are beginning to move upwards. The quotations for parcels of mixed Bessemer iron are steady at from 44s. 6d. to 46s. per ton net, f.o.b., and the market is rising. It is confidently expected that Bessemer qualities will reach 47s. per ton net before Christmas, although this is a season of the year when trade is generally expected to be quieter. The business doing is on a liberal scale, and it is evident that stocks are being reduced to a great extent in consequence of the restriction in output. This restriction will be maintained by arrangement, so that it is probable there will be a considerable reduction in stocks before the spring of next year, and that prices will be increased, if not to a great extent, at any rate to such a figure as will afford a profit to the producer. This has not in all cases been possible of late, but the action taken by makers is likely to make it so. The notice served by makers in West Cumberland on their workmen of a reduction of 10 per cent. in their wages is likely to lead to some difficulty. The men have not shown any disposition to agree to the proposal, and they are considering a second proposal for the adjustment of a sliding scale in which masters offer them 2½ per cent. on every 2s. 6d. increase in the price of pig iron, and *vice versâ*. It is threatened that a lock-out will ensue if the men do not accept the proposal, and in the event 6000 men would be affected. The general view of the position is that a settlement will be come to without great difficulty, especially in view of the rising market. The steel trade is again reported more brisk, and orders are freely offering from all sources. Makers are well employed at the rail mills, and new orders are plentiful. There is no change to note in the trade for steel for shipbuilding purposes, which remains quiet; but all the other detachments of the steel trade are active. Rails are quoted at £4 5s. to £4 6s. per ton net, f.o.b., for heavy sections, and billets at £4 per ton. The work in the hands of shipbuilders is very limited, and orders are few. The same remark still applies to engineers, both in the marine and general departments. The only new feature of the week is the order which has been placed in the hands of Messrs. Westray and Copeland, engineers, of Barrow, for important structural alterations in the steamer King Orry, including new compound engines and new boilers. The iron ore trade is steady and firm, and a good demand exists. Ordinary qualities find a market at from 9s. to 11s. 6d. per ton net at mines. Coal and coke steady and in large consumption. Shipping is fairly employed. The general industries of the district are short of work.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE dispute in the West Cumberland iron district affects Sheffield to the extent that one large firm—Messrs. Charles Cammel and Co.—have a considerable number employed at their Derwent Works. In the Sheffield district ironworkers' wages are regulated by South Staffordshire. No rupture takes place, the remuneration rising and falling by the decisions of the Conciliation Board. In the Cumberland districts the employers appear bent upon obtaining a reduction of 5 per cent., which the men are determined to resist. A further suggestion was made that the men should accept a 2½ per cent. reduction if iron went below 44s. 6d., and if it went above that price, an advance of 2½ per cent. would be given for each 2s. 6d. advance in iron. This is equivalent to a sliding-scale system. It is interesting to note that the delegates declined to accept any sliding-scale arrangement "until they were instructed in it." This is precisely the difficulty in the coal-field of South and West Yorkshire. The miners state that they do not understand the sliding scale, and every effort made at an understanding to establish a principle of self-regulating for wages falls through, when the coalowners and the Union officials meet, on one point. That is the starting point. Neither party can agree on the price which shall be taken as standard value. If the minimum value of coal could once be decided, the other difficulties would promptly disappear.

At Barnsley, on Saturday, the adjourned conference of the delegates of the Yorkshire Miners' Association, and the representatives of Yorkshire collieries generally, met to receive the report of Mr. John Frith and Mr. James Murray, who were deputed to attend the Newcastle conference. After five hours' consideration, the Barnsley conference decided in favour of restricting the output, to demand an advance of 10 per cent. in wages, and to agitate for the establishment of a board of conciliation "for the regulation of general and local rates of wages." A deputation was appointed to meet the coalowners on these questions, and to ask for an interview. In the adjoining Derbyshire coalfield a ballot has been taken to test the feeling of the miners on the wages question at the Manners, Cossall, and Oakwell Collieries. The result, as might have been anticipated, was pretty unanimously in favour of advance. Cossall Colliery—300 papers delivered, 269 returned in favour of an advance; 2 spoilt; against, 0. Oakwell—217 papers delivered, 190 in favour; against, 8. Manners—250 papers delivered, 235 returned in favour; against, 0. After these figures it was an easy stage to reach by resolution—"That all the men combine to fight the battle unless an advance is given; that nothing less than 3d. per ton be accepted, as the indirect reductions have been so numerous that the miners find it impossible to get a living at the present rate of wages."

Winter weather set in with snow on Wednesday, and the cold snap is having the usual effect in moving house coal. The tonnage to London and the South is well maintained. Gas coal is being freely delivered, the late foggy weather having added considerably to the consumption both in the metropolis and in the country. An extra demand, however, does not affect the values of this class of coal, as the quantities are contracted for early in the season. The weight of engine fuel, slack, and other sorts for steam generating purposes, shows that the volume of business in the manufacturing districts is not to be complained of. A better price is what the markets need, more than increased business.

A strong feeling prevails here that our arsenals, stores, and ships should not be supplied and equipped by importations of steel projectiles from foreigners when manufacturers in Sheffield are able and willing to supply all demands, for equal material, at lower prices. The Hadfield Steel Foundry Company, of Sheffield, who have been experimenting for a long time, are reported in the *Times* to have equalled, if not surpassed, the foreign-made shells by sending a 6in. shot through a Cammell 9in. compound plate and smashing it. In a further trial, they afterwards, with a 12in. shot, penetrated and broke a Brown 16in. compound plate. These tests, if accurately represented—as there is no reason to doubt—prove more than appears on the surface. Sheffield plates were never so good as they are now, and the success of the Hadfield shells shows the progress which is also being made in Sheffield projectiles.

I am glad to hear very satisfactory reports concerning Mitis castings. Many well-known engineers and machinists are now adopting them extensively for a large variety of somewhat complicated articles where thorough soundness is essential, and where forged iron or steel was previously only applicable, and which had to be afterwards manipulated to shape. It will be remembered that the manufacture of these castings at present is especially confined to smaller work in this country and solely carried on at Sheffield. "Mitis" metal will weld or harden. Castings are supplied in a short time, and they are of remarkable toughness and soundness. They are of Swedish wrought iron or steel quality, depending upon purpose. Lord Thurlow, Mr. Nordenfelt, of ammunition fame, and others interested visited the preliminary plant which has been in active use for some time at the Canal Steel Works in Sheffield, belonging to Messrs. Hansell and Company, the licensees, and were highly gratified with results.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE iron market held at Middlesbrough on Tuesday last was unusually well attended, and the tone was much firmer and more cheerful than it has been for some time past. A considerable amount of business was done. Buyers are now showing great eagerness to purchase for forward delivery, and prices are slowly but steadily advancing. Merchants decline to take less than 32s. 3d. per ton for prompt, and 32s. 9d. for forward delivery, which is a rise of 6d. per ton in both cases. During the last few days makers have sold a large quantity of iron for delivery over the first three months of next year. They are not willing, however, to commit themselves for further large quantities at present prices, and for small lots for prompt delivery they have raised their quotations to 32s. 6d. per ton. Forge iron is in better demand, in consequence of greater regularity in the working of the rolling mills. The price has advanced 3d. per ton over and above that of the previous week's market, sales having been made on Tuesday at 30s. 6d. per ton.

Warrants are now 33s. per ton, which is an advance of 2s. 1½d. on the price current a month ago.

On Monday last Messrs. Connal and Co.'s stock of pig iron was 326,797 tons, which represents a decrease of 107 tons during the week.

The finished iron trade is at last showing signs of improvement. Inquiries are more numerous than for some time past, and several new orders have been placed. Makers are therefore somewhat excited and have raised their prices to the following, viz.:—Ship plates, £4 10s. per ton; boiler plates, £5 10s.; common bars, £4 12s. 6d.; best bars, £5 2s. 6d.; ship angles, £4 5s.; all free on trucks at makers' works, less 2½ per cent. discount. Puddled bars are £3 per ton net.

The total quantity of pig iron shipped at Middlesbrough last month was 64,488 tons, of which Scotland took 33,507 tons; Germany, 7150 tons; Italy, 4685 tons; Belgium, 3575 tons; Holland, 3160 tons; Portugal, 2355 tons; Sweden, 1036 tons; and America, 1000 tons. The manufactured iron exported amounted to 29,330 tons. India was the best customer having taken 18,134 tons. Steel exports reached 20,761 tons, of which India took 11,529 tons, and 3626 tons went to British Burmah.

The ironmasters' monthly statistics, which have just been issued, show that ninety-three blast furnaces were at work on the 30th of November, as compared with ninety-five on the 31st of October. Of these, fifty-one are producing Cleveland, and the remainder hematite, spiegel, and basic iron. The total quantity produced of all kinds was 209,152 tons, or 12,613 tons less than during October. The stocks in the district amounted in the aggregate to 629,925 tons, which is an increase of 1721 tons over those existing a month ago.

Mr. Wm. Gray, Mayor of West Hartlepool, senior partner in the firm of Wm. Gray and Co., and a member of Lloyd's Committee, is certainly a most enterprising man. Not content with his present extensive iron shipyard at West Hartlepool, and the Central Marine Engine Works, of which he is principal owner, and with the possession of a large fleet of merchant steamers, he is about still further to extend his operations. He has just commenced to lay out a new shipyard and graving dock. The site chosen adjoins the Central Marine Engine Works. When these works are completed, Mr. Gray's firm will be in a position to undertake the complete construction of steamers of the very largest size, and orders for even ships of war will not be refused.

Some sensation has been created among shipbuilders and marine engineers in the North of England, by the announcement that representatives of important French and English shipbuilding firms have recently been visiting Spain, and negotiating with the authorities there, with a view to establish shipyards and marine engine works on the banks of the Bilbao river. This tendency for British capital to emigrate to foreign countries is somewhat significant. It certainly prejudices the industrial future of the country, for a comparatively small present benefit. The greatest sufferers in the long run will be the British working men. If they remain at home they will find, perhaps, that they are no longer required; if they follow the capital to foreign countries they will have to work twice as long per week as at present for half the money, and adapt themselves to foreign ways and a foreign language. No doubt this result is largely due to the restrictive policy of trades unions in this country.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE past week has been a rather exciting one in the Glasgow pig iron market. Prices of warrants advanced to a higher level than before, but there have been frequent variations. Brokers report that there is much more speculative inquiry than usual, and that a not inconsiderable portion of it comes from the south. Were it not for the large current output and heavy stocks, it is all but certain that prices would have advanced much more rapidly. The past week's pig iron shipments were 6284 tons, against 4289 in the same week of last year. Of this amount, 1130 tons went to the United States, 150 to South America, 375 to Australia, and 1440 to Italy. The shipments are smaller than was anticipated, but it is thought those for the remaining weeks of the year may show comparatively well. There are eighty-four furnaces in blast, against sixty-six at the same time last year. The week's addition of stock in Messrs. Connal and Co.'s stores is about 2000 tons.

Cumberland hematite warrants have sold well in our market at advanced prices, owing to the activity in the steel trade. Scotch hematite meets with a brisk consumptive demand at higher quotations.

Values of makers' pigs are higher, as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 47s. 6d.; No. 3, 44s.; Coltness, 51s. and 44s.; Langloan, 48s. and 44s.; Summerlee, 49s. 6d. and 43s. 6d.; Calder, 47s. 6d. and 40s. 6d.; Carnbroe, 43s. 6d. and 40s.; Clyde, 45s. 6d. and 40s. 6d.; Monkland, 43s. 6d. and 40s.; Govan, at Broomielaw, 43s. and 40s.; Shotts, at Leith, 47s. 6d. and 44s. 6d.; Carron, at Grangemouth, 49s. and 43s.; Glengarnock, at Ardrossan, 46s. 6d. and 41s. 6d.; Eglinton, 43s. and 40s.; and Dalmellington, 43s. 6d. and 40s. 6d.

The steel trade is in an active condition, but I learn from the makers that the amount of actual work placed within the last few weeks has been greatly exaggerated in the daily papers and in speculative circles. Many of the orders from the shipbuilders are conditional upon future contracts being placed, and it is probable that for a considerable part of this work specifications may never be issued. The amount of the advance in the price of steel has also been over-stated. The report was current on 'Change that ship plates had gone up 10s. per ton. The truth is that the bottom price was £6, and the actual advance for work placed is 3s. 9d., making the price £6 3s. 9d., and other articles are influenced in proportion. Should trade continue to improve, however, it is highly probable that additional advances will not be long delayed. The Steel Company of Scotland has abandoned for the present the proposed reduction of wages, and has given the men 1d. extra on "commons," to bring it up to the other class of work.

There are encouraging reports this week as to the malleable iron trade. It is gradually improving, and in the course of the past week prices have risen 1s. 3d. all round. Best bars are now quoted £5 1s. 3d.; merchant bars, £4 15s. 1d.; rivet iron, £4 16s. 3d.; nut iron, £4 12s. 6d.; angles, £4 15s.; and plates, £5 8s. 9d., all f.o.b. at Glasgow, less 5 per cent. discount. Contracts are reported to be booked at the advanced prices, which will keep the works busy for some time, and buyers that were holding off are now providing for their requirements.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THERE is a certain amount of activity in most of the steel works, and yet managers express themselves as not exactly satisfied with the condition of things. The general quotation for rails—heavy sections—has fallen to £4, and at this figure one might expect that not only would colonists put in large orders, but extensive "renewals" would be bought. This is not the case. The Americans take blooms in tolerably large quantities, but rails are not in demand. The most important cargo of the week was to Port Limon, 1100 tons, with 200 tons of machinery from Newport. Excepting Cyfarthfa, which is doing a large trade at present, though it could have been wished at better prices, the Monmouthshire works are doing the best, and Newport is showing larger consignments of steel generally than Cardiff.

Ironmasters need not be much surprised at the dearth of rail orders, seeing that Burmah, Japan, China, and other countries are still hesitating about becoming civilised railway-using places. As for renewals, I was over a great breadth of English and Welsh railways lately, and the notices placed here and there of the last renewals of steel rails, with the date, were disheartening. Notwithstanding the immense traffic, the rails looked as good as ever. In the saving of platelayers' labour alone railways are greatly benefitted.

I only express the prevailing opinion of the Welsh coal and iron world in contending that rates should be systematically reduced. This week large quantities of pig iron have been received at Swansea by sea route from the North of England and from Scotland in successful competition with Welsh works. Taking Swansea as a buyer, Barrow is able at any time to undersell Dowlais, though the rail route from that place is only thirty miles. The local papers are taking up the question with vigour.

In the question of coal, the complaints of coalowners are quite as loud in reference to rates. They say that prices have fallen to the minimum, but that railways exact the same rates, and middlemen the same commission, as when prices were double.

There is a better tone in the coal trade. At the Cardiff Exchange on Tuesday a good deal of satisfactory business was done, and coasting freights reported as steady. Quotations were firm at last week's prices; bunker coal bought freely from 8s. to 8s. 3d. House coal is also in fuller requirement, and for best qualities 3d. advance is readily obtained. Small "building" coal continues in good demand and at the previous high rates. I note that Dowlais is getting large quantities from the Rhondda Valley, principally "Lewis's Merthyr." Dowlais is also a free buyer of foreign ore, and the company, as well as Ebbw Vale and others, are receiving large consignments from Bilbao. It was reported in Cardiff this week that Glasgow is entering into large contracts for Bilbao ore over next year at a rate of 6s. 8d. per ton freight.

The Dowlais Steel Works' transfer to Cardiff is still a prominent topic. Business steps are being taken, and renters of land on the moors have had orders to give up possession on the 31st of this month to the Dowlais Company. People at Dowlais are much divided in opinion about the transfer, as new operations continue at the old works, especially at the Goat Mill, where there was a portion started a few days ago. It may, however, be accepted that all new development and improvements will be reserved for the new works, which are to be upon a large scale. The statement given to me, on the best authority, is that they will be second to none in the kingdom, and quite on a par with the American steel works. These we know to be in keeping with the colossal character of most of the American industries. Dowlais Works at Cardiff will, in addition, have the benefit of appliances and inventions of the latest date. Practical operations are to begin early in the new year, and will be rapidly pushed on, expenditure being, in the opinion of the promoters, of less account than time.

The report is current in the district that a Sheffield company has concluded arrangements with the proprietor of the Hirwain Ironworks for its purchase in order to transform them into crucible steel works. It is a fact that negotiation has been entered into, but I cannot yet affirm the settlement.

A Monmouthshire ironwork company is also stated to be in treaty for Pentyrch ironworks. This I give with reserve. Many rumours current as to sale of works and collieries will not stand investigation. It was stated lately that the Messrs. Cory had acquired Gadlys collieries. The fact is negotiations were opened but abandoned. The collieries remain in the hands of the Wayne Company, of which Mr. Soulanger, Cardiff, is the worthy representative.

Swansea port has been active of late, coal shipments being large, and the tin-plate trade busy. Last week close upon 30,000 boxes of plate were despatched, New York alone taking 1000 tons, and New Orleans 600 tons. Taking the vessels due into consideration, a busier week this week still is certain. At the Exchange this week a good deal of business was done, and orders booked at the advanced prices now quoted. Latest figures are—Martin's, 15s. 3d. to 16s.; Bessemer steel, 15s. 9d. to 16s.; Siemen's, coke, 16s. to 16s. 3d.; ternes, 28s.; wasters, 6d. to 9d. per box less than prices. The tin corner was, of course, the principal subject of discussion, and it was agreed that great care was necessary in business, as a collapse any day was likely.

The latest movement amongst the colliers is to reduce the output. This, in their opinion, will bring about improved prices. An agitation to this end has been started in various districts, and principally at Plymouth and the Ocean. At the latter place a movement is on foot to increase the minimum of scale.

At Plymouth last week a collier, holding a superior position to the ordinary, was detected smoking near the lamp station. Pressure for exemplary punishment will be made.

Pitwood is falling again on account of the market falling. Prices, 15s. 6d. to 15s. 9d.

A new industry is to be started at Monmouth—wagon works, for which the place appears to be well adapted.

The Cardiff Colliery Supply Company is announced; capital, £10,000.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE sustained exertions made in all quarters to counteract the former disastrous native competition, by coming in one shape or another to a common understanding, are ever giving a firmer stamp to the iron markets of the country, and so the present situation of them continues satisfactory. Demand is in general pretty brisk, and several rises in price can be pointed out. The reports from Silesia also continue to show a cheerful tone in the market for crude as well as finished iron, and the iron merchants at Breslau have just sent out circulars announcing another advance in prices. The neighbouring market of Belgium continues to manifest the same firm attitude it has done for weeks past, and in anticipation of the increased import duties in Italy coming into force next January, is sending away very large lots of rolled girders and steel rails to that country, whilst in France the iron business in general is undoubtedly looking more promising than of late, but in Austria it has become rather weaker, pending the definitive renewal of the lapsed iron combination.

As specially concerns the Rhenish-Westphalian and western district iron trade, regarding the ore trade there is but little change to note as yet, but it may be looked upon as certain that the position of the market at Bilbao will soon react favourably on the native mines, for it is reported within the last few days from there that, "in consequence of the exceptionally large orders received, freights to Rotterdam have considerably advanced again, and that deliveries are likely to be greatly retarded, as such an overwhelming amount of orders have to be effectuated." The demand for Luxemberg ores both for home and export account is very full, and prices are firm at from M. 2·20 to 3·20 p.t. at mines for the red, yellow, and grey sorts. The prolongation for a year of the crude iron convention has naturally had a strengthening effect on pigs, and consequently there is a little better demand for certain sorts. A common sales bureau could not be accomplished at the late meeting, but, as last week reported, a unanimous advance of M. 1 to 1½ p.t. was agreed upon.

Spiegeleisen, though not in good demand for abroad, is still firm in price as last noted. Forge pig has been very animated all through the week at M. 46·50 to 48 for superior sorts, and almost all the furnaces have contracted for their next quarter's outturn, and as over production is not visible, prices are not likely soon to recede. There was, and indeed still is, a lack of basic pig, consequently English had to be resorted to, but this is being remedied by an increase of production here. The new price of basic is M. 44, and of Bessemer pig M. 49·50 p.t. In the Siegerland, forge pigs have also gone up M. 2 p.t.; and although these works do not belong to the Rhenish-Westphalian convention, they are profiting by it to this extent; but, of course, with the first panic, they would be the first to cause a drop, and then where would the famous convention be? Foundry pig is in moderate demand at prices as noted last week. The common wrought iron sales-bureau arrangement seems to give satisfaction so far, and the stipulated prices are being willingly paid by buyers. The rolling mills are sufficiently supplied with orders for a long time to come, but orders are not coming in so freely as a short time back; but this condition of things is not unusual before the winter sets in. The stock of hoops in merchants' hands seems to have been cleared out, for the demand for them is now most eager and is especially strong, the present price being M. 127·50 to 130 p.t. Boiler and common plates are not animated at all, and constantly remain at M. 150 p.t. for 5 mm. gauge and above. They ought to be dearer to pay at present prices of raw materials, but a brisk demand is wanting altogether. Sheets continue in full demand at M. 142 p.t., and the price has not yet been raised again in harmouy with the new rise in forge pig, though it has been proposed to do so shortly. The galvanising works are as busy as they can be. Tinned plates have been raised M. 1 per box on account of the rise in tin. The only change to note in wire rods is that those in iron have been advanced to M. 116 and those in steel to 115 p.t. Export to America is very dull. At the last tendering at Magdeburg for 8700 t. of steel rails, the Westphalian Works offered as lowest prices M. 116 and 116·50 p.t.; others ranged 119 to 122. No Belgian offers came in, but two from England, one at 120·40 free at Magdeburg, and another 116·80 at Altona. At the beginning to the present month 9000 t. of rails, 12,500 t. of sleepers, and 800 t. of fish-plates are to be tendered for at Elberfeld, and 7500 t. of sleepers by the Baden railways. The great want of orders at the wagon factories will be to a small extent relieved by the giving out this month of 185 divers sorts of rolling stock. In comparison to a month or so back the constructive shops of all sorts are better supplied with orders, and complaints are less rife. Some machine shops have plenty of work, but no further improvement in prices is noticeable, and this is now the sore point.

Foreign iron blooms for the manufacture of telegraph wire, to be subsequently exported, are to be allowed to enter here free of duty, subordinate to an official control of the finished article on again leaving the country.

The coal trade is very brisk, not only seasonably so, but especially in industrial sorts. Gas and flaming coal costs M. 6·40 to 8·00; furnace do., 5·40 to 6·20; lumps, 7·80 to 8·60; cokes for foundry use, 5·50 to 10; furnace do., 7·60 to 8·50; and broken do., nut size, 8·50 to 10 p.t. at mines.

What would be thought in England if a ministerial organ were to begin to lecture the iron manufacturers upon what they ought or ought not to do in their business? Yet this is what the *North German Gazette* of Berlin, always credited with being a Government organ, has done. It begins an article by praising the accomplishment of the wrought iron convention—sales bureau—and then goes on to lecture those works, which have kept aloof from it, as wanting in *esprit de corps* and a proper appreciation of the social and political policy of the country now in vogue; in fact, as taking no solid interest in the well-being of the national economical policy, and so on, and intimates that for this they have forfeited the right, which the convention members have thus earned, to expect further protection for their productions. This almost reminds me of the paternal tutelage we were formerly subject to—not so very long ago either—in working our mines, when our Government official came each month to the mine, regulated where work was to be carried on, set the stints, settled the wages; and another official—of course at the expense of the mine—calculated and paid the wages; the mine-owner being allowed to find the capital, look patiently on, and either dispose of, or work up the minerals gotten, after the Government tenths had been paid. Of course, it is well known what the motives for the present economical and social policy are, but the above article seems rather one-sided, and it is a question whether, while one set of workmen are in this artificial way, as it may perhaps be called, continued at work, by means of the convention as here understood, another set, engaged in the constructive manufacturing processes, will not be reduced in numbers, through inability of the masters to compete abroad on account of the enhanced prices of raw materials. With all this, accompanied by the heavy sums to be paid to the Government Sick and Pension Fund for Workpeople, with the same anti-socialistic object, the latter fund requiring, as it will in a short time, millions of marks a year—It is calculated that in a year or two's time the district of Dortmund alone will have to find 108 million marks yearly for pensions to workpeople—it must appear to onlookers that the coal and iron industry of this country is drifting into a questionable position, for protection cannot do everything.

The Société d'Aciereries de France has decided to lay down a plant in Spain to produce and manufacture steel.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, December 1st.

THE receipts of tin-plate during the past week were 40,895 boxes; tin, 217 tons; pig iron, 1380 tons; spiegeleisen, 1296 tons; steel and iron rods, 1029 tons; old rails, 2282 tons. Very few new orders have gone abroad. Freights are a little too high, and the probabilities on this side are that production will be restricted, owing to the backwardness of steel rail buyers in placing orders. The situation is about as it was thirty days ago, excepting that more conservative views are prevailing. The railroad companies have for some time anticipated a reduction in the price of rails from 40 dols. to 30 dols. Rail makers are prepared to shut down their mills if prices go below 32 dols. There are inquiries for very large quantities, variously estimated at from 200 to 250,000 tons. At present makers are asking 32·50 dols. The sales of Lake copper during the week were 3,100,000 lb. at from 11·70 to 12·75. The market is very strong. The exports of copper for the week were 224,526 lb.; total since January 1st, 10,564,777 lb., against 16,791,650 lb. for same time last year, as against 32,516,723 lb. for same time in 1885. Liberal sales of lead have been made at 4·25; total, 1100 tons for the week. The merchant steel manufacturers have effected a strong combination, and prices are about 5 per cent. stronger than before. The consumption of tin in the United States since January 1st is estimated at 11,750 tons, against 10,750 tons for same time last year. The production of anthracite iron from 125 furnaces is 36,720 tons per week, and of bituminous iron from 148 furnaces, 94,982 tons per week. The total producing capacity, including charcoal furnaces, is 145,847 tons per week, against 122,731 tons per week, and a year ago 312 furnaces were in blast, against 350 furnaces now. The iron trade throughout the country is in a very good condition. Manufacturing interests are careful to not permit any accumulation of stocks. The anthracite coal trade at this point is in an unsettled and excited condition. It is with great difficulty sufficient supplies are obtained for urgent requirements, and prices are advancing.

The American market is rather excited over tin, copper, lead, and tin-plate. A large amount of business has been done during the past week. Sales still foot up 3,500,000 lb. Exports so far this year, 10,789,576 lb., or a little over half the exports of last year to this date. The exports of copper matte and ore for the past week were 2,600,964 lb., and for year 48,902,490, against 45,616,400 lb. for same time last year. The market for tin-plates has been very strong and active, and a slight advance has been made. Charcoal tins, ½x, Melyn grade, 5·62½ dols.; Calland grade, 5·37½ dols., and 1·50 dols. for 1x.; Grange grade, 5·30 dols.; Allaway's grade, 5·00 dols., and 1 dol. for 1x. Charcoal ternes, Worcester, 14/20, 4·75 dols.; 20/28, 9·35 dols.; Dean grade, 14/20, 4·40 dols.; 20/28, 8·80 dols.; Abercarne grade, 14/20, 4·30 dols.; 20/28, 8·60 dols. Coke tins, I.C. 14/20, J.B., Grafton, Glyn, &c., 4·75 dols. Bessemer steels, 4·70 dols.; B.V. grade, 4·65 dols.; stamping plates, squares, &c., Siemens-Martin, 4·90 dols., basis; Bessemer, 4·80 dols., basis. Steel rails are in dull demand; quotations, 32·50 dols. to 33 dols.

In Scotch pig iron sales are moderate at recent prices. Coltness, 21 dols. to 21·50 dols.; Summerlee, 20·50 dols. to 20·75 dols.; Glengarnock, 20 dols. to 20·50 dols.; Dalmellington, 19 dols. to 19·25 dols. Lead is quoted at 4·40. Advices from the interior show great activity in all kinds of iron and steel. An immense amount of building is projected for next year, and all kinds of crude and finished material will be firm in price throughout the winter. An abundance of capital, both American and foreign, is seeking investment in new localities. The pig iron furnaces throughout New York and Pennsylvania are pretty well sold up for about three months. The Chief of Engineers has asked for an appropriation of some 2,500,000 dols., to be expended in the erection of coast defences and in torpedo work. The request will probably be granted.

NEW COMPANIES.

THE following companies have just been registered:—

City of London Steamboat Company, Limited.

Upon the river Thames and other rivers, and elsewhere, this company proposes to carry on the business of a steamboat company in all its branches. It was registered on the 24th ult., with a capital of £60,000, in £1 shares, with the following as first subscribers:—

	Shares.
*J. G. Rhodes, 7, Southwark-street, hop merchant	1
*J. Graves, jun., Thomas Griffin Wharves, Tooley-street	1
*S. H. Hewitt, St. Aubyn, Kingston Hill, underwriter	1
*M. Mowat, 47, Granville Park, Blackheath, merchant	1
*Colonel H. R. Abadie, 1, Suffolk-place, Pall-mall	1
*G. Green, 14, Cooper-row, Towerhill, wharfinger	1
R. O. Amlot, 168, Albion-road, Stoke Newington, clerk	1

The number of directors is not to be less than five, nor more than seven; qualification, 500 shares. The first are the subscribers denoted by an asterisk. Remuneration—250 guineas per annum to the chairman, and 150 guineas per annum to each director, and a further sum, equal to 10 per cent. of the amount available for dividend after 10 per cent. per annum has been paid. The directors are the founders of the company; and if within a period of five years the dividends for any two consecutive years reach an average of 7½ per cent. per annum, they will be entitled to 3000 fully-paid ordinary shares.

Orient Electric Light Company, Limited.

Registered on the 29th ult., with a capital of £5000, in £250 shares, to carry on in the United Kingdom, India, Burmah, Ceylon, or elsewhere, the business of an electric lighting, telephone, and telegraph company. The subscribers are:—

	Shares.
W. Martineau, C.E., 6, Great Winchester-street	1
R. Hedges, C.E., 25, Queen Anne's-gate, S.W.	1
B. Low, 29, Mincing-lane, merchant	1
W. J. Andrewes, Palace-chambers, Westminster, solicitor	1
J. W. P. Woodroffe, 1, East India-avenue, merchant	1
S. Hedges, 83, Lombard-street	1
H. Tate, 21, Mincing-lane, sugar refiner	1
F. J. P. Birch, 8¼, Angel-court, stockbroker	1

Most of the articles of Table A of the Companies' Act, 1862, apply.

Payta Petroleum Company, Limited.

This company was registered on the 30th ult., with a capital of £300,000, in £1 shares, to purchase certain petroliferous lands known as the Hacienda Mina Brea, situate in the province of Payta, in Peru, and to sink wells and otherwise to search for and obtain petroleum and other mineral oils and products. The subscribers are:—

	Shares.
G. J. Hunt, 16, Goldsmith-gardens, Acton	1
F. T. Marney, 12, Bradley-road, Wood-green, clerk	1
C. T. Whinney, 4, Furnival's-inn, solicitor	1
W. H. Adams, 168, Friern-road, East Dulwich, accountant	1
E. T. Botwright, 23, Sutton-place, Hackney, accountant	1
J. Alexander, Dunley-street, Peckham, solicitor	1
A. F. Solomon, Leatherhead	1

The number of directors is not to be less than three, nor more than seven; qualification, £250 in shares; the subscribers are to appoint the first; remuneration, £100 per annum each.

Railway, Tramway, and General Appliance Company, Limited.

On the 19th ult. this company was registered, with a capital of £100,000, in £5 shares, to construct, equip, and work railways, tramways, and other works of public utility, and to carry on the business of mechanical and electric engineers, machine and engineering tool makers. The subscribers are:—

	Shares.
J. Alexander, Danby-street, Peckham, accountant	1
F. H. Marney, 12, Bradley-road, Wood-green, clerk	1
E. T. Botright, 23, Sutton-place, Hackney, accountant	1
J. H. Chapman, 64, Wellington-street, Woolwich, shorthand writer	1
S. J. Prosser, 84, Loampit-vale, Lewisham, surveyor	1
E. S. Harper, Goodrich-road, Forest-hill, accountant	1
W. C. Horton, 7, Moncrieff-street, Peckham, shorthand writer	1

The number of directors is not to be less than three, nor more than five; qualification, £100 in shares. The subscribers are to nominate the first. The company in general meeting will determine remuneration.

Portland Electric Light Company, Limited.

Registered on the 30th ult., with a capital of £45,000, in £5 shares, to carry on the general business of an electric light and power company. The subscribers are:—

	Shares.
G. E. Cockburn, Sudbury, Harrow	1
A. Williams, 11, Bisham-gardens, Highgate	1
F. J. Oliver, 96, Holly-street, Dalston	1
R. Hunter, 80, Paxton-road, Chiswick	1
P. W. Felbrigg, The Bank, Highgate, engineer	1
W. A. Fenn, 16, Hunsden-road, Hatcham, designer	1
C. Mason, 6, Elm-grove, Cricklewood, draughtsman	1

The number of directors is not to be less than three, nor more than five; qualification, £100 in shares; the subscribers are to appoint the first. The directors may divide £150 per annum as remuneration for their services.

South Metropolitan Electric Supply Company, Limited.

This company was registered on the 26th inst., with a capital of £250,000, in £10 shares, to carry on in all branches the business of an electric light and power company. The subscribers are:—

	Shares.
J C. Packman, J.P., 91, Victoria-street, S.W.	1
E. R. Creed, 1, Boldry-gardens, Streatham, accountant	1
W. Stopford Smyth, C.E., Newport, Mon.	1
T. L. Eastlake, Fairlawn, Balham	1
J. P. Linton, 15, Melrose-terrace, West Kensington, solicitor	1
J. Beavan, 9, Blucher-road, Camberwell	1
S. Bircham, 46, Parliament-street, solicitor	1

Registered without special articles.

Storey-Poore Submerging Torpedo Boat Company, Limited.

This company proposes to acquire the submerging vessel or torpedo boat Nautilus, now lying in the Tilbury Docks, and to acquire the following letters patent relating to submarine boats and to improved means for supporting and feeding torpedoes to torpedo-discharging apparatus, viz.:—No. 16,915, dated December 24th, 1884; No. 6163, May 6th, 1886; No. 3746, May 11th, 1887; No. 3447, May 11th, 1887; No. 4227, March 21st, 1887. It was registered on the 25th ult., with a capital of £14,000, in £10 shares. The subscribers are:—

	Shares.
A. L. Lyon, Thetford, Norfolk	1
Mrs. Florence Mary Wolseley, Holme Chase, Weybridge	1
Andrew Campbell, 36, Pembury-road, Lower Clapton	1
*Graydon Poore, C.E., 49, Queen Victoria-street	1
*W. C. Storey, 13, Regent-street, naval architect	1
E. Latham, A.I., Southwark Bridge-road, engineer	1
*J. A. James, Kenilworth	1

The number of directors is not to be less than three, nor more than seven; qualification, £20 in shares or stock. The first are the subscribers denoted by an asterisk.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Application for Letters Patent.

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

29th December, 1887.

16,360. WASTE PREVENTING VALVES, J. W. Smallman, London.
16,361. AUTOMATIC PIPE COUPLING, W. F. Grassler and W. G. Elliot, London.
16,362. CONSTRUCTION, &c., of WIRE WORK, G. C. Mohr, Birmingham.
16,363. TYPE-WRITING MACHINES, W. W. Evans, London.
16,364. COLOURING and SMOKING PIPES, E. M. Hobirk, Birmingham.
16,365. PREVENTING the SPLASH from WHEELS, J. Hayward, Wolverhampton.
16,366. RAISING the GALLERIES of LAMPS, F. R. Baker, Birmingham.
16,367. MACHINERY for SPINNING YARN, A. Ambler and H. K. White, Halifax.
16,368. PUMPS, P. J. Neate, Rochester.
16,369. ADVERTISING, P. J. Jackson, Newcastle-on-Tyne.
16,370. SHUFFLING CARDS, A. G. Brookes.—(*S. Tingley, United States.*)
16,371. HOSIERY, M. Tomlinson, Bakewell.
16,372. GATHERING, &c., RAIN, &c., R. C. Sayer, Redland.
16,373. CONTINUOUS BRAKES, W. H. Blakeney, Nethergate.
16,374. SWITCHBACK RAILWAY, E. Richardson and B. Wright, New Clee.
16,375. COMBINED BATH and HOT TANK, A. Dougill, Leeds.
16,376. ELECTRIC ARC LAMPS, C. B. and R. D. Noble, London.
16,377. WATER BEDS, J. Cockburn, Glasgow.
16,378. AUTOGRAPHIC TELEGRAPHS, H. J. Allison.—(*The Writing Telegraph Company, United States*)
16,379. STANDS for DRESSES, W. R. Lake.—(*W. H. Knapp, United States.*)
16,380. STANDS for DRESSES, W. R. Lake.—(*W. H. Knapp, United States.*)
16,381. FILTRATION of LIQUIDS H. Berghoff, London.
16,382. TURRETS, R. C. Christie, M. Gledhill, and H. H. S. Carington.—(*J. B. G. A. Canet, France.*)
16,383. CENTRAL DRAUGHT LAMPS, J. Y. Johnson.—(*C. S. Upton, United States.*)
16,384. TABLETS, J. Y. Johnson.—(*The Volta Graphophone Company, United States.*)
16,385. METALLIC JOINTS, S. and F. Thompson, Tamworth.
16,386. MACHINES for DELIVERING ARTICLES, &c., H. F. Studds, London.
16,387. AUTOMATIC FIRE EXTINGUISHING SPRINKLERS, J. H. and J. W. Galloway, London.
16,388. WHEELS, T. Groom, Birmingham.
16,389. JOINING PIPES, A. Ellis, London.
16,390. BOTTLES, W. R. Lake.—(*G. A. Fullerton, United States.*)
16,391. AUTOMATICALLY EXTINGUISHING FIRES, W. R. Lake.—(*J. T. Dyer, United States.*)
16,392. PRODUCING PERMANENT COLOURED LINES, &c, H. E. Slade, London.
16,393. FURNACES, T. F. Cashin, Normanville.
16,394. PLAYING MUSIC, J. C. McGee, Glasgow.
16,395. RIVETTING, C. Hall, London.
16,396. PEAT for FIRE-LIGHTERS, &c., J. H. Pearson, London.
16,397. LOCK and LATCH FURNITURE, J. Pollock, London.
16,398. SUPPLY of LIQUIDS on DRAUGHT, B. W. Warwick, London.
16,399. AUTOMATIC VENTILATING APPARATUS, E. Kent, London.
16,400. LOOMS for TUFTED or PILE FABRICS, S. Z. Lloyd, London.
16,401. ATTACHING ORNAMENTS to RINGS, T. B. Sharp, Smethwick.
16,402. ROLLER-BLIND and other FITTINGS, W. Cluse, London.
16,403. DELIVERY of LIQUIDS, F. Schilling, J. G. A. Brüning, and H. Stollwerck, London.
16,404. TRAMWAY VEHICLES, W. R. Lake.—(*W. H. Patton, United States.*)
16,405. SHOE-STIFFENERS, G. H. Fox and L. W. Lombard, London.
16,406. TELEGRAPHIC TRANSMISSION, P. B. Delany, London.
16,407. SPLINTS, A. Caller, London.
16,408. BUCKLES for SUSPENDERS, &c., W. J. Walters, London.
16,409. BOOTS, M. Sesenwine, London.
16,410. LUBRICATORS, P. Brownley, London.
16,411. HEATING RAILWAY CARRIAGES by STEAM, J. Henney, jun., London.
16,412. LOCK-UP BOTTLE STANDS, A. Watson, London.
16,413. EXTINGUISHING LAMPS, A. Davies and J. C. Corbett, London.
16,414. CENTRE SECONDS STOP WATCHES, P. H. Lawrence and F. L. Turner, London.
16,415. AUTOMATIC SALE and DELIVERY of GOODS, E. Amory and H. Born, London.
16,416. SCREW PRESSES, E. Breslauer, London.
16,417. PORTABLE FOLDING or JOINTED FRAMES, R. G. Barrie, London.
16,418. OPENING and CLOSING FLUES of DOMESTIC FIREPLACES, F. J. Baynes, London.
16,419. RING SPINNING, &c., APPARATUS, O. Imray.—(*A. S. J. Miron and T. E. Wilson, France.*)
16,420. SPHERICAL ENGINES, R. H. Heenan, London.
16,421. ILLUMINATING FLOUR MILLING MACHINERY, H. Simon, London.
16,422. MULTI-COLOURED PLUSH FABRICS, W. Weegmann, London.
16,423. BUTTONS for GARMENTS, A. J. Boult.—(*H. Thier, Germany.*)
16,424. TELEGRAPHIC INSTRUMENTS, W. P. Thompson.—(*C. J. Burke, United States.*)
16,425. KNITTING MACHINES, A. J. Boult.—(*J. C. Stearnes, Bautzen.*)
16,426. JOINT for CROSSING PARTS of CORRUGATED METAL, W. P. Thompson.—(*H. C. Hodges, United States.*)
16,427. LOCKS, J. E., R. H., and T. S. Elgood, London.
16,428. AUTOMATIC STEERING SIGNALS for SHIPS, A. R. Leask, London.
16,429. CORRUGATING PAPER, A. J. Boult.—(*E. Salzkorn and L. Nicolai, Germany.*)
16,430. RANGE FINDERS for MACHINE GUNS, J. A. Norton, London.
16,431. JURY RUDDERS for SHIPS, G. F. Redfern.—(*F. S. Cormier, New Brunswick, and W. H. Johnson and J. P. Angrove, Nova Scotia.*)
16,432. KITCHEN or COOKING RANGES, T. Rogers, London.
16,433. WATER METERS, M. P. Freeman, London.
16,434. COPYING PRESS, L. Saget, London.
16,435. RAILWAY SIGNALLING APPARATUS, J. Hill, W. Smith, and J. P. O'Donnell, New Malden.
16,436. STEEL, G. J. Snelus, London.

30th November, 1887.

16,437. ATTACHING PRONGS, &c., of BUCKLES, W. W. Twigg and J. Luckock, Birmingham.
16,438. VENTILATING STOPPER, G. Stanton, London.
16,439. PLOUGHING, &c., LAND, W. P. Thompson.—(*A. A. H. de Beauquesne, France.*)
16,440. UMBRELLAS, W. P. Thompson.—(*Messrs. Rabow and Freadenburg, Prussia.*)
16,441. RAILWAY CHAIR KEYS or WEDGES, R. M. Eastman, Liverpool.
16,442. VENTILATING FANS and AIR PROPELLERS, H. Jackson, Manchester.
16,443. STEPS for SHAFT, &c., BEARINGS, J. Shepherd, Manchester.
16,444. WALKING and UMBRELLA STICKS, A. Cotgreave, London.
16,445. SHARPENING HORSES for FROST, N. Bird Workington.
16,446. PRESSING DOMESTIC LINEN, T. Bradford, Manchester.
16,447. RESERVOIR for PETROLINE LAMPS, J. Copeland, Birmingham.
16,448. EYE-GLASSES, L. A. Groth.—(*J. J. Scheidig, Germany.*)
16,449. MOTIVE SPRING POWER MACHINE, T. Hubble, London.
16,450. LOOMS for WEAVING, W. Gardner and E. S. Ware Halifax.
16,451. APPARATUS for GRINDING SUBSTANCES, A. Lamberton, Glasgow.
16,452. SUPPLY of MEASURED QUANTITIES of LIQUIDS, J. Holroyd, Manchester.
16,453. SMOKELESS GUNPOWDER, J. A. Wanklyn, H. M. Maclure, and W. A. Byrnn, London.
16,454. EYES for STAIR RODS, W. H. Baraclough, Birmingham.
16,455. SECONDARY or STORAGE BATTERIES, H. Thame, London.
16,456. PREVENTING AIR and DUST PASSING UNDER DOORS, F. Cook, Halifax.
16,457. AIR-TIGHT BOXES, G. C. Kirtley, Stockton-on-Tees.
16,458. ELECTRIC TELEPHONES, A. A. C. Swinton London.
16,459. SASH FASTENER, D. Knowles, Willenhall.
16,460. TURNIP and POTATO WASHER, MacN. C. Bowie, Kilbarchan.
16,461. COOKING RANGES, G. Kinnaird and R. McAdam Glasgow.
16,462. DRILLING MACHINES, W. Barraclough, Glasgow.
16,463. SIGHT-FEED LUBRICATOR, G. Robertson Glasgow.
16,464. SAND SUPPLY BOX, A. H. Synge, London.
16,465. MILITARY TRICYCLES, &c., J. L. Watkins, London.
16,466. SPINDLES and FLYERS, J. Shorrocks, London.
16,467. BEATING EGGS, &c., T. H. Heard and W. K. Birkinshaw, Sheffield.
16,468. WATCH CHAINS, W. H. Lord, Birmingham.
16,469. TANNING, F. H. Colley, Sheffield.
16,470. APPARATUS for TILTING RAILWAY WAGONS, G. Taylor, Cardiff.
16,471. SAFETY BICYCLE for TWO RIDERS, E. A. Reynolds, London.
16,472. WASHING MACHINES, N. J. Hannemann London.
16,473. ELECTRICAL SIGNALLING DEVICE, S. S. Bromhead.—(*S. T. Street, United States.*)
16,474. AUTOMATIC MACHINE for the SUPPLY of ELECTRICITY, B. W. Warwick, London
16,475. STENGTHENING TENNIS RACQUETS, W. H. Butlin, Stonehouse.
16,476. RIVETTED GALVANISED TELEGRAPH POLES, W Bayliss and E. Jones, London.
16,477. FRONT WINDOWS of CABS, Forder and Co. and E. Cund, London.
16,478. FLOORS for BALL ROOMS, W. J. Snawdon, London.
16,479. ARTICLES of WIRE WOVEN FABRIC, A. Arnold, London.
16,480. SPOKES for WHEELS, J. Huxtable, London.
16,481. FOLDING CARD-BOARD BOXES, R. E. and A. T. Kühn, London.
16,482. CURE of ECZEMA, M. A. Kerry, London.
16,483. LUMINOSITY of CIRCULAR FLAMES, J. Swift, London.
16,484. AZO DYES, J. Y. Johnson.—(*The Farbenfabriken vormals F. Bayer and Co., Germany.*)
16,485. WEIGHING MACHINES, E. Edwards.—(*E. C. Marc, France.*)
16,486. HEATING and COOLING ROLLERS, J. Lawton, Manchester.
16,487. ORNAMENTING GLASS, T. W. Webb, London.
16,488. SYPHON CISTERNS, R. L. and E. Howard and R. S. Lloyd, London.
16,489. PRODUCTION of FORCE for MECHANICAL PURPOSES, A. Melville, London.
16,490. DRYING GRAIN, E. Delbecchi, London.
16,491. CLEANSING TIN, H. W. Buddicom, London.
16,492. BRAIDING MACHINES, J. Lami, London.
16,493. AZO DYES, J. Y. Johnson.—(*The Farbenfabriken vormals F. Bayer and Co., Germany.*)
16,494. EMBROIDERING MACHINES, &c., H. A. Walke London.
16,495. EXTRACTING METALS from ORES, W. R. Lake —(*A. Vogelmann, Germany.*)
16,496. ADJUSTING the HARNESS of LOOMS, C. Schulder, London.

1st December, 1887.

16,497. STEEL, B. H. Thwaite and J. Noble, Liverpool.
16,498. FISHING-ROD SPIKE FITTINGS, T. Kirker, Belfast.
16,499. SEWING MACHINE ATTACHMENT, E. W. Whitehall, Nottingham.
16,500. DRIVING BELTS, J. Taylor, Manchester.
16,501. ARTIFICIAL FUEL, L. Wacks, London.
16,502. FACILITATING the EGRESS of PEOPLE from THEATRES, A. W. Hitchin, Birmingham.
16,503. SPRING CLIPS and HOOKS, M. Myers and J. Lowe, Birmingham.
16,504. RACK PULLEYS, G. Shelvoke, Birmingham.
16,505. SASH WINDOWS, W. Phillips and E. Verity, Leeds.
16,506. SASH FASTENERS, F. H. Collins, Birmingham.
16,507. INDICATOR for DOOR FASTENINGS, F. H. Collins, Birmingham.
16,508. WATER WASTE PREVENTERS, T. L. Switzer, Newport, I.W.
16,509. GUM DAMPERS, W. Leggott, Bradford.
16,510. IMITATION of MARBLE, &c., B. and W. Oldfield, Coventry.
16,511. HYDRAULIC RIVETTING MACHINES, J. and H. Smith, Glasgow.
16,512. HANDLE and LOCK for DOORS, &c., B. Clark, jun., Birmingham.
16,513. PRUNING SHEARS and SCISSORS, J. Lloyd, Horbury, near Wakefield.
16,514. GUILLOTINE CUTTING MACHINES, T. Furnival, E. Tudor, jun., C. Preston, and W. Byway, Manchester.
16,515. SAFETY SADDLE or STIRRUP BARS, J. Frearson, Birmingham.
16,516. OINTMENT ROLLER for the BODY, J. J. Brüderlin, London.
16,517. MOUNTING of the TAKING-OFF APPARATUS of PRINTING MACHINES, T. Furnival, E. Tudor, jun., C. Presson, and W. Byway, Manchester.
16,518. BRACELET, &c., R. F. Dorendorff, London.
16,519. DRAWING NAILS, &c., J. Furnace, Liverpool.
16,520. CASES for PROTECTING BOTTLES, W. R. Comings, London.
16,521. BOXES or CASES, A. H. Storey, London.
16,522. FLYERS for SLUBBING, &c., MACHINES, T. Howarth, London.
16,523. STEAM and HYDRAULIC PISTON VALVES, G. W. Willford and F. Nicholson, Sheffield.
16,524. DRILLING MACHINES, W. W. Hulse, London.
16,525. STUD or BUTTON, S. Chubb, London.
16,526. TEACHING WEIGHTS and MEASURES, G. Evans and F. W. Levander, London.
16,527. SANITARY AUTOMATIC DISINFECTANT DISCHARGER, G. F. Restall, Bournemouth.
16,528. GAME or PUZZLE, W. J. Payne, London.
16,529. MANUFACTURE of BRICKS, S. Bond, London.
16,530. SHIPS, &c., D. Wilson, London.
16,531. VELOCIPEDES, C. E. Burton.
16,532. WASHING MACHINE, E. Edwards.—(*E. Martin, Germany.*)
16,533. PRINTING MACHINES, W. B. Silverlock, London.
16,534. FEEDING COAL to FURNACES, E. Edwards.—(*E. Cambiaso, I. Colombo, and G. N. Mangini, Italy.*)
16,535. TUBULAR JOINTS, W. Lee and D. Wiggins, London.
16,536. HOOKS for BOOTS, W. L. Wise.—(*G. Klotz, Austria.*)
16,537. APPLYING ELECTRICITY to PROPEL VEHICLES, F Wynne, London.
16,538. RECORDING EXACT TIME PERSONS SHUT and

Open Places of Business, M. G. Kelso and C. Reichert, Glasgow.
16,539. Automatically Delivering Cigars, &c., E. Thomson, London.
16,540. Saddles, H. R. Stewart, London.
16,541. Lubricators, S. Reid, London.
16,542. Pen Handle, E. A. Claremont, London.
16,543. Scraping the Insides of Retorts, F. Pool, London.
16,544. Bollards, H. Fletcher, London.
16,545. Separating Liquids, J. S. Sawrey and H. Colect, London.
16,546. Solitaires, A. Eisen, London.
16,547. Writing Music, &c., G. G. M. Hardingham.—(A. Tessaro, Italy.)
16,548. Blast Pipes, H. Appleby, London.
16,549. Pitch Chains, H. Imray.—(J. A. Jeffrey, United States.)
16,550. Projectiles, G. Kynoch and H. A. Schlund, London.
16,551. Lamps, C. Crastin and E. A. de Pass, London.
16,552. Stoppering Bottles, F. Rutard and F. Delas, London.
16,553. Extracting Gold, &c., from their Ores, A. Schanschieff and D. Marks, London.
16,554. Electric Apparatus, G. Binter, London.
16,555. Tubular Boiler, O. Lilienthal, London.
16,556. Self-engaging Couplings for Vehicles, J. Bühr, London.
16,557. Mattresses, E. Solomon, London.
9749a. Knife Sharpener, W. Hartmann, Paris.—12th July, 1887.—[This application having been originally included in No. 9749, dated 12th July, 1887, takes under patents Rule 23 that date.]

2nd December, 1887.

16,558. Measuring Electric Currents, A. Wright, London.
16,559. Measuring Electrical Currents, A. Wright, London.
16,560. Water Hose, A. G. Bradshaw, London.
16,561. Cast Steel Rake and other Heads, J. Trippett and J. T. Key, Sheffield.
16,562. Self-adjustable Chairs, &c., A. Hodge, London.
16,563. Controlling the Flow of Water in Pipes, H. Trott, London.
16,564. Bracelets, &c., W. Leuchars, London.
16,565. Electrical Measuring Instruments, E. Thomas, London.
16,566. Mangers and Manger Framing, J. G. L. Stephenson, London.
16,567. Outdoor Amusement, T. Needham, Huddersfield.
16,568. Curry Comb for Horses, &c., W. Gamble, Bromley.
16,569. Pocket Dispensing Scales, W. L. Haymes and J. Morris, Coventry.
16,570. Water Meter for Steam Boilers, J. A. Rowe, North Shields.
16,571. Thermo-dynamic Engines, J. Hargreaves, Liverpool.
16,572. Pistons, J. Campbell, Stoke-on-Trent.
16,573. Railway Signalling, J. H. da Fonseca, Heaton Moor, near Stockport.
16,574. Automatic Delivery of Articles, F. H. Urry, London.
16,575. Tobacco Pouches, T. Greatrex, J. Record, and J. Whitehead, Birmingham.
16,576. Photographic Roller Slides, J. E. Thornton, Manchester.
16,577. Closing Doors, J. Tourtel, London.
16,578. Hoists and Lifts, S. G. Bennett, Handsworth.
16,579. Travelling Tablet, T. Clifford, Birmingham.
16,580. String, &c., Fastener, H. Williams, Glasgow.
16,581. Steam Generators, W. H. Wise, West Hartlepool.
16,582. Distillation of Gas, &c., J. Dempster, Manchester.
16,583. Regulating Electric Arc Lamps, F. C. Phillips and H. E. Harrison, London.
16,584. Regulating Electric Motors, F. C. Phillips and H. E. Harrison, London.
16,585. Holding Pile Fabrics, C. Longbottom, Bradford.
16,586. Penholders, J. C. Morrell and S. C. Maguire, Pinner.
16,587. Howells' Embrocation, D. Howells, Glyncorrwg, near Bridgend.
16,588. Preservers for Pickers in Looms, E. T. Whittaker and M. J. Whittaker, Halifax.
16,589. Carding Machines, J. Eadie, Fermanagh.
16,590. Trusses for Hernia, J. A. Sherman, London.
16,591. Stop-motions for Looms, H. Butler, London.
16,592. Preventing the Second Fermentation of Yeast, C. R. W. Offen and A. T. More, London.
16,593. Opening and Closing Windows, E. Thorp, Lewisham.
16,594. Separating Liquids from Solid Matter, J. S. Sawrey and H. Colect, London.
16,595. Steam Generators, J. S. White, G. E. Bellis, and A. Morcom, London.
16,596. Apparatus for Conveying Sand, A. C. Henderson.—(P. Bony, France.)
16,597. Stoppering Bottles, &c., J. Reade, London.
16,598. Parallel Rulers, F. J. Hall, London.
16,599. Holding together the Ends of Wire, G. A. Billington, Liverpool.
16,600. Securing the Lids of Gas Retorts, &c., A. G. Browning and M. R. Waddle, Bradford.
16,601. Construction of Glazed Roofs, O. André, London.
16,602. Writing Desks, H. Nicholson, Glasgow.
16,603. Electric Lamps, A. J. Boult.—(R. Weber, Germany.)
16,604. Utilisation of Scrap, &c., Plates, A. S. Ramage, Liverpool.
16,605. Skates, J. R. Topham, London.
16,606. Rifles, J. Hillebrandt, London.
16,607. Lighting by and Burning of Oils, &c., F. B. Maddison, London.
16,608. Raising and Lowering Window Blinds, G. G. Potter, London.
16,609. Ornamental Handles for Umbrellas, &c., J. N. Kuhn, London.
16,610. Opening and Closing Windows, &c., R. Adams, London.
16,611. Watches, E. de Pass.—(The Firm of Kuhn and Tièche, Switzerland.)
16,612. Anglers' Spinning Tackle, &c., H. Livesey, London.
16,613. Sleepers, &c., J. Howard and E. T. Bousfield, London.
16,614. Loading Revolvers, &c., W. de C. Prideaux, London.
16,615. Velocipedes, W. Bown and A. T. Andrews, London.
16,616. Rail Cleaners for Railways, H. Conradi, London.
16,617. Heating Radiator, G. Harvey, London.
16,618. Boat for Recreational Purposes, W. Stobbs, London.
16,619. Lift or Elevator, S. P. Wilding.—(J. E. A. Amiot, France.)
16,620. Projectiles, W. R. Lake.—(G. F. Simmonds, United States.)
16,621. Moulding and Pressing Tiles, J. Larmanjat, London.
16,622. Machine Tool, W. R. Lake.—(T. Urquhart, Russia.)
16,623. Generators, W. T. Goolden and L. B. Atkinson, London.
16,624. Machinery for Advertising, H. A. Burt, Liverpool.

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16,625. Apparatus for Disinfecting Books, G. Cooper, Sheffield.
16,626. Road Wheels, S. Eddington and J. E. Steevenson, Chelmsford.
16,627. Loose Reed Motions of Looms, T. Grimshaw, Halifax.
16,628. Braces, H. Land, Manchester.
16,629. Drying Apparatus for Sizing, Z. Holden, Halifax.
16,630. Extinguishing Mechanism for Lamps, F. R. Baker, Birmingham.
16,631. Pipes, A. F. Firth, Halifax.
16,632. Worsted Fabrics, C. Holdsworth, Halifax.
16,633. Fittings for Trouser Braces, C. N. Eyland, Birmingham.
16,634. Drilling Machines, A. E. Stayner, Mill-houses.
16,635. Cigarettes, H. P. Millar, London.
16,636. Springs for Vermin Traps, T. P. Bache, Birmingham.
16,637. Wire Metallic Rod, F. and A. S. Elmore, Cumberland.
16,638. Combined Boot and Skate, C. Hudson, Northampton.
16,639. Joints for Pins of Brooches, E. L. Downing, London.
16,640. Keyboard for Key Instruments, E. Höfinghoff, Barmen.
16,641. Preparing Materials for Smelting Purposes, F. Caulfield and A. Allan, Glasgow.
16,642. Nail Scissors and Cigar-cutter, L. H. Turtle, Sheffield.
16,643. Indicating Static or Dynamic Force, F. C. Lynde, Manchester.
16,644. Automatically Signalling at Sea, C. A. Cousin and J. Brindley, London.
16,645. Shutters for Signalling Lamps, J. L. Watkins, London.
16,646. Heliographs, J. L. Watkins, London.
16,647. Folding Fan Stove Screens, A. Mullord, London.
16,648. Cameras, V. W. Delves-Broughton, London.
16,649. Safety Locks for Doors, &c., V. Jeannot, London.
16,650. Sight-feed Lubricators, J. Farmer, Glasgow.
16,651. Metallic Packing for Stuffing-boxes, D. B. Hutton, London.
16,652. Preparing Ferment of Rennet, F. Graeff, London.
16,653. Felt, J. B. Mégemond, jun., M. E. and J. B. A. Mégemond, and C. J. M. A. Raffard, London.
16,654. Charging and Firing Blast Holes, A. Figge, London.
16,655. Injectors, E. Körting, London.
16,656. Liquor Taps, G. A. Sweetser, London.
16,657. Removing Scale from Tubes, H. J. Haddan.—(A. Rost, Austria.)
16,658. Fire-escape, &c., H. J. Haddan.—(J. Diss, Germany.)
16,659. Reed Musical Instruments, E. Wellner, London.
16,660. Securing Pieces of Leather, G. B. Mallinson and W. Speight, London.
16,661. Driving Gear for Velocipedes, J. A. Score, London.
16,662. Cattle Cribs, E. Pratt, London.
16,663. Hasps for Locks of Trunks, E. C. Thomasson, London.
16,664. Abdominal Belts, J. Arnold, London.
16,665. Treatment of Spherical Articles by Attrition, G. W. Niblett, London.
16,666. Steam Boilers, W. Davies, Sheffield.
16,667. Vehicles for Carcases, &c., W. C. Mowbray, London.
16,668. Nut-lock, &c., J. S. Fairfax.—(F. C. Glaser, Germany.)
16,669. Secondary Battery, M. Bailey and J. Warner, London.
16,670. Steam Generators, I. S. and J. T. McDougall, London.
16,671. Combined Toilet Hut, &c., G. F. Redfern.—(E. Amiel, France.)
16,672. Ships' Signal Lights, A. and H. Brock, London.
16,673. Musical Instruments, W. G. Ackerman and G. H. Best, London.
16,674. Cutting Cloth, M. W. Taylor, G. F. Thomas, and H. C. Taylor, Bristol.
16,675. Joining Wire Rope, T. C. Batchelor and A. Latch, London.
16,676. Protecting Corners of Meat from Burning, W. S. Simpson, London.
16,677. Metal Laths, E. Nunan, London.
16,678. Laying Underground Electric Conductors, E. W. Beckingsale, London.
16,679. Oil Can, H. Lucas, Birmingham.

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16,680. Upper Leathers of Boots, &c., T. Brining, Leeds.
16,681. Fastening Electro-plates on Blocks, A. Légé and W. Kelly, London.
16,682. Stamping Samples, T. C. Thompson, Manchester.
16,683. Manufacture of Screw Hooks, F. French, Handsworth.
16,684. Combination with a Latch, R. L. Burkitt and G. W. Green, London.
16,685. Moving Spanner, O. Banks, London.
16,686. Artificial Teeth, E. H. Sherman and J. B. Parker, London.
16,687. Combined Deck Seat, J. J. Peck, Glasgow.
16,688. Direct Action Winches, A. Higginson, Liverpool.
16,689. Preserving Cockles, H. J. Williams, W. J. Pritchard, T. R. Parry, and L. R. Evans, Llanllechid.
16,690. Signal Lights on Ships, R. Pickwell, Cardiff.
16,691. Fastening for Windows, F. Hughes, Weston-super-Mare.
16,692. Alarm Fog Signal, T. L. Soar and D. Eastwood, Sheffield.
16,693. Release Alarm Engine Starter, R. Sugden, Salford.
16,694. Lamps for Mines, &c., W. J. S. McCleary, London.
16,695. Circular Wick Lamps, F. R. Baker, Birmingham.
16,696. Generating Electricity, T. R. Weston, London.
16,697. Fastening Handles to their Spindles, J. Davies, Wednesbury.
16,698. Mechanical Stokers, W. Mellor, Manchester.
16,699. Composition for Wicks of Lamps, W. Defries and V. I. Feeny, London.
16,700. Medicinal Tablets, C. Willson, Grimsby.
16,701. Detecting Irregularity in Postage, C. J. Eyre, London.
16,702. Tobacco Pipes, M. M. Yergatian, London.
16,703. Match Magazines, A. J. Boult.—(J. S. Foley, United States, and J. Ruse, Canada.)
16,704. Mules for Spinning, S. Syddall, London.
16,705. Spinning Top, A. H. Valda, Chiswick.
16,706. Dowel Action Stretching Frame, W. J. Dearen, London.
16,707. Lock-stitch Sewing Machines, G. Fischer, London.
16,708. Combing Machines, J. C. Walker, London.
16,709. Electrical Generators, T. A. Edison.—[Received 5th December, 1887. Antedated 13th June, A.D., 1887, under International Convention.]
16,710. Prime Motors, T. A. Edison, London.—[Received 5th December, 1887. Antedated 13th June, A.D., 1887, under International Convention.]
16,711. Musical Skipping Rope, C. Wells and L. Ritchie, London.
16,712. Musical Spinning Tops, C. Wells, London.
16,713. Extinguishers for Lamps, &c., A. Bösch, London.
16,714. Discovering Leaks in Ships, T. Thorbiornsen, London.
16,715. Lubricators, C. D. Austin, London.
16,716. Gas Governors, G. Bray, London.
16,717. Therapeutic Apparatus, P. A. Newton.—(F. J. Kneuper, United States.)
16,718. Lubricating Devices, S. Pitt.—(J. C. Nichol, Canada.)
16,719. Automatic Delivery Machines, E. J. Ball, London.
16,720. Horse-clipper, D. du Boulay, Salisbury.
16,721. Cartridges, W. P. Thompson.—(The Compagnie Générale des Explosifs Favier, Belgium.)
16,722. Gates, A. Aird, London.
16,723. Velocipedes, G. D. Leechman, London.
16,724. Collapsible Boxes, A. M. Clark.—(J. Hotham, United States.)—[Received 5th December, 1887. Antedated 3rd May, A.D. 1887, under International Convention.]
16,725. Scarves, W. Post, Iserlohn.
16,726. Scarves, G. Hughes.—(E. A. Doucet, France.)
16,727. Aluminium, A. B. Cunningham, London.
16,728. Incandescent Electric Lamps, A. Heintz, London.
16,729. Starting Tramway Vehicles, F. Foster, London.
16,730. Branding Tool, G. E. Pettett, London.
16,731. Fastenings for Bags, &c., H. H. Lake.—(Wirth and Co., Germany.)
16,732. Purification of Saccharine Juices, &c., E. Breyer, London.
16,733. Cleaning Carpets, &c., S. Simmons and J. Tullidge, London.
16,734. Conveying Money or Goods, H. H. Lake.—(W. R. Cole and F. H. Edwards, United States.)
16,735. Pulley for Belting, W. J. Bosley and W. W. Dickson, London.
16,736. Stuffing-box Packings, W. E. and F. G. Brockett, London.
16,737. Preserving Seeds and Plants, P. L. Quarante and Madame V. d'Escalonne, London.

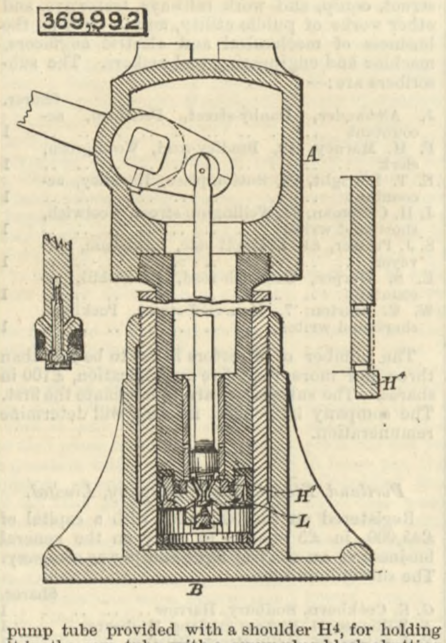
SELECTED AMERICAN PATENTS.

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

369,992. Hydraulic Jack, *O. H. Mechem, Connellsville, Pa.—Filed January 16th*, 1885.

Claim.—(1) In a hydraulic jack, a pump tube having an annular by-passage in its walls connected with the pump tube way, combined with a perforated pump plunger having its travel way in the pump tube extended below such passage connection. (2) In a hydraulic jack, a pump tube having a by-passage opening into it from the side with countersunk or rounded edges, combined with a pump plunger having its travel way across such opening. (3) In a hydraulic jack, the combination of a ram having a removable

369,992

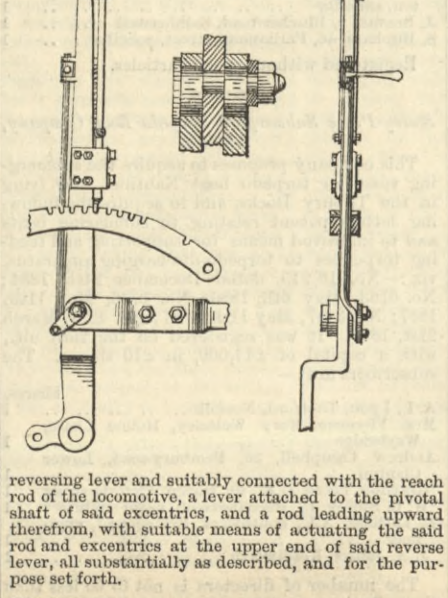


pump tube provided with a shoulder H^4, for holding it in the ram tube, with a screw plug block abutting against both the pump and ram tubes to hold the pump tube in place. (4) In a hydraulic jack, the combination of a ram having a removable pump tube provided with a shoulder H^4, for engagement with the ram tube, with a screw plug block L, bearing a valved passage and abutting against the pump tube to hold it in place. (5) The combination of the head A and base B, having telescoping cylinders, with a pump therein, having a passage through its plunger head and a covered by-passage in its walls, and with a plug block to close the end of the pump tube, provided with a valved passage, having a stem to its valve adapted to be engaged by the plunger to open the valve and permit fluids to flow back and around the plunger head.

369,994. Reversing Lever *J. Player, Marshalltown, Iowa.—Filed April 13th*, 1887.

Claim.—In a locomotive reversing lever, the combination of excentrics centrally pivotted in said

369,994

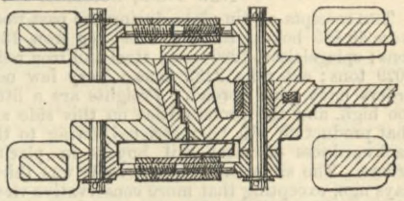


reversing lever and suitably connected with the reach rod of the locomotive, a lever attached to the pivotal shaft of said excentrics, and a rod leading upward therefrom, with suitable means of actuating the said rod and excentrics at the upper end of said reverse lever, all substantially as described, and for the purpose set forth.

370,002. Crusher for Ores, *P. S. Balkwill, Cleveland, Ohio.—Filed November 29th*, 1886.

Claim.—In an ore crusher, the combination of the casing with the vibrating adjustable jaws, the faces of said jaws being oblique to the axis of vibration and

370,002

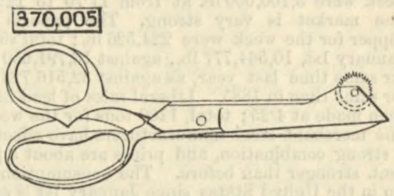


formed with interlapping step-like offsets, substantially as described.

370,005. Convertible Implement for Cutting and Marking, *F. E. Buddington, Chicago, Ill.—Filed June 4th*, 1887.

Claim.—The herein described convertible implement, consisting of a pair of shears or scissors having the forward end of one of its blades enlarged and provided

370,005

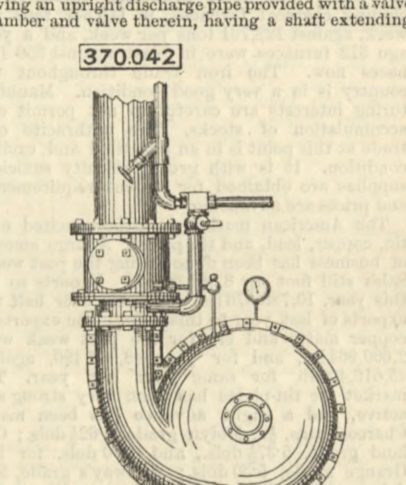


with a pocket in said enlarged end, and a tracing wheel journalled in the said pocket, as specified.

370,042. Centrifugal Pump, *J. G. Bruggeman, Cleveland.—Filed January 6th*, 1887.

Claim.—The combination of a centrifugal pump having an upright discharge pipe provided with a valve chamber and valve therein, having a shaft extending

370,042

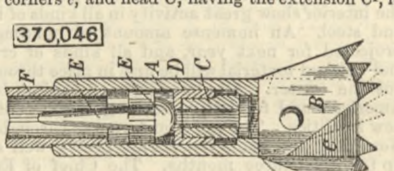


through the wall of said chamber, and an ejector connected with the discharge pipe below said valve, all constructed and arranged to operate substantially as described, and for the purpose specified.

370,046. Expansion Drill, *M. T. Chapman, Aurora, Ill.—Filed July 11th*, 1887.

Claim.—(1) The coupling A, having an interior chamber to receive a lifting valve, in combination with with the head C, having a neck or extension, C^1, and carrying cutting blades, and having an inner passage communicating with the chamber of the coupling, substantially as and for the purpose specified. (2) The coupling A, in combination with the blades B, having the corners *c*, and head C, having the extension C^1, for

370,046

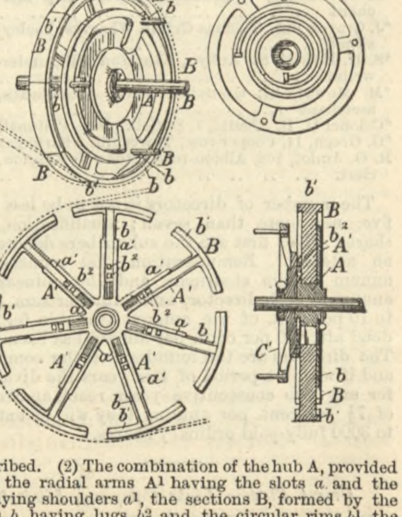


expanding the blades from the force and weight of the drill rod, substantially as specified. (3) The coupling A, in combination with the blades B, having the ends *c*, head C, having a water passage, and collar D, for operating the blades or bits of a drill rod, substantially as specified. (4) The coupling A, blades or bits B, having the ends *c*, head C, having a water passage, and collar D, in combination with lifting valve F, for operating the blades and raising the cuttings, substantially as specified.

370,087. Expansion Pulley, *B. J. Riley, North Walpole, N.H.—Filed June 24th*, 1887.

Claim.—(1) The combination of the hub A, provided with the radial arms A^1, having the slots *a* and the overlying shoulders a^1, the sections B, formed by the arms *b* having lugs b^2, and the circular rims b^1, and the disc C having the spiral way c^1 directly engaging with the lugs b^2, and adapted upon rotation to simultaneously move all the arms substantially as

370,087



described. (2) The combination of the hub A, provided with the radial arms A^1 having the slots *a* and the overlying shoulders a^1, the sections B, formed by the arms *b*, having lugs b^2 and the circular rims b^1, the disc C, having the spiral way c^1 directly engaging with the lugs b^2, and the clamping collars and their screws substantially as described.