THE ENGINEER.

THE REACTION AND EFFICIENCY OF THE SCREW PROPELLER.

A very valuable and interesting paper "On the Reaction and Efficiency of the Screw Propeller," was recently (March, 1887) read before the North-East Coast Institution of Engineers and Shipbuilders, by Mr. A. Blechynden. The author has taken great pains not only over experiments described in this paper of his own, but also in discussing the experiments of Mr. Isherwood made in America about twelve years ago. Holding the high opinion that we do of the value of Mr. Blechynden's paper, we hope that the author will pardon us if in carefully analysing his work we point out some obscurities of statement and argument which could, with a very slight alteration, be easily rectified in another edition, if the author should be prevailed upon to amplify and continue his present investigations.

In the first place, in all such investigations, whether comparative or absolute, too much care cannot be taken at the outset in settling on a convenient notation and terminology, and in defining the units employed.

Let us take, then, the three fundamental units, as usually employed by engineers, to be the foot as the unit of length, the pound as the unit of weight, and the minute as the unit of time—not the second, as customary in theoretical investigations. In the first place, the value of g, the acceleration of gravity, instead of being roughly 32, must now be multiplied by 60^2, and will therefore be 115,200; it is important to bear this in mind.

Let us also, following Rankine as far as possible in his paper on the "Mechanical Principles of the Action of Propellers" (Trans. I.N.A., 1865), adopt the following notation:—

v = velocity of the steamer in feet per minute;
u = velocity of feed of the propeller; so that
$v - u$ = velocity of the wake relative to the surrounding water;
p = pitch of the propeller in feet;
n = revolutions, that is, number of turns per minute of the engines; then
$n\,p$ = speed of screw; and
$n\,p - u$ = real slip of the screw in the wake, and then the ratio $(n\,p - u) \div n\,p$ is called the real slip ratio, and denoted by s, $100\,s$ being the percentage of slip;
$n\,p - v$ = apparent slip, and $(n\,p - v) \div n\,p$ is called the apparent slip ratio.

If the speed of the wake is greater than the real slip, the apparent slip will be negative; but the real slip must always be positive for the screw to have a propelling thrust.

Again, let
d = diameter of propeller in feet;
a = diameter of the boss; also let
A = disc area of the propeller;
B = boss area; so that
$A = \frac{1}{4}\pi d^2$, $B = \frac{1}{4}\pi a^2$;
w = density of water in lbs. per cubic foot; for sea water we may take $w = 64$, for fresh water $w = 62{\cdot}4$.

Instead of taking the formulæ used by Mr. Blechynden at the beginning of his paper, let us first assume the formulæ given in The Engineer, June 4th, 1886, for L the turning couple of the propeller in foot-pounds, and T the thrust in pounds, namely—

$$L = \frac{w}{g}(A^2 - B^2)\,u\left(n - \frac{u}{p}\right) \quad . \quad . \quad . \quad . \quad . \quad (1),$$

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

The value of T is derived from the value of L in accordance with Prop. V. of Mr. Blechynden's paper; this is in reality Lagrange's principle of Virtual Velocities, but Mr. Blechynden can hardly say that it is so self-evident as to need no proof. Granting, however, either equation (1) or (2), the other one follows at once by his Prop. V. "In any screw $T p = 2\pi L$, *i.e.*, thrust into pitch is equal to 6·28 into the turning moment."

This proposition of course implies that fluid friction is left out of account; experimental verification showing very close agreement is given in Table VIII., where a motive weight W applied at a distance of 6·125in. from the axis was so adjusted as to make the thrust T = 5·6; the slight discrepancy between the columns of pitch × thrust and orbit × motive weight must be set down to the effect of fluid friction.

We have begun with Prop. V., as Props. II., III., IV. are all implied in V., and consequently are unnecessary; while Prop. I. must be accepted as a deduction from Mr. Isherwood's experiments. Herewith follow with comments Mr. Blechynden's propositions.

Prop. I.—"In any screw the turning moment is independent of the quantity of surface or of the mode in which it is distributed." In other words, the turning moment is a function only of the diameter, pitch, and revolutions of the screw, and of the speed of the feed and the density of the water, quantities we denote by d, a, p, n, u, and w. The screw by its revolution generates a certain amount of angular momentum per minute in the water passing through it, and this angular momentum from mechanical principles must be equated to the turning moment L, no deduction being required for fluid friction.

Prop. II.—"Screws of equal diameter tried under similar conditions have turning moments directly proportional to their pitch ratios for equal thrusts."

Prop. III.—"Screws with equal pitch ratio have turning moments proportional to their diameter when indicating equal thrusts."

Prop. IV.—"Screws tried under similar circumstances have turning moments proportional to their pitches when indicating equal thrusts;" these Propositions, I. to IV., are all included in Prop. V., and merely repeat the formula $T p = 2\pi L$, from the definition of "pitch ratio" as the ratio of pitch to diameter.

Expressing u, the velocity of feed, in terms of s, the true slip ratio, formula (2) for the thrust becomes

$$T = \frac{w}{g}(A^2 - B^2)\,2\pi n^2\,s\,(1 - s) \quad . \quad (3);$$

in practice the ratio $B^2 \div A^2$ is so small that it may be neglected, and B may be replaced by zero.

But if we compare the results of this formula with the experimental results of Mr. Isherwood given in Table IX., we shall find great discrepancies, the theoretical value of the thrust being about three times the experimental value. The reason of the discrepancy is twofold; first, it is not clearly stated whether the speed in knots is the speed of the vessel, or the speed of feed of the propeller; these two velocities differing by from ten to twenty per cent. according to the lines of the stern of the vessel, and thus we are uncertain whether the slip per centum in line 4, Table IX., refers to real or apparent slip. Secondly, no account has yet been taken in formula (3) of the thrust deduction due to fluid friction.

Now it was shown in The Engineer of July 9th, 1886, and March 18th, 1887, that when fluid friction is taken into account, the formula (3) for the thrust must be replaced by

$$T = \frac{w}{g}(A^2 - B^2)\,2\pi n^2\left\{s\,(1 + k) - k\right\}(1 - s) \quad . \quad (4)$$

where k is a certain constant, in practice always small, depending on the surface ratio of the propeller, and the coefficient of friction of the surface of the blades. If we put $k = 0$ we recover formula (3). Incidentally (3) and (4) confirm Mr. Blechynden's corollary, (p. 192), that with constant slip ratio the thrust varies as the square of the revolutions or the square of the advance.

Perhaps the readiest way of determining k experimentally is to find out the slip ratio s at which the propeller just begins to exert thrust; then $s\,(1 + k) - k = 0$, or $s = k \div (1 + k) = k$, approximately.

Also, keeping the revolutions n constant, and varying the feed u, the thrust T is a maximum, when

$$s = \frac{1 + 2k}{2 + 2k} = \frac{1}{2} + \frac{k}{2 + 2k}, \text{ a little more than } \tfrac{1}{2};$$ so that the slip percentage is then a little over 50.

Applying this to the experiments of Mr. Blechynden, who found that the maximum thrust was obtained with a speed of the screw of 1·324 knots, with 0·63 knots speed of feed, we find $s = 1 - (0{\cdot}63 \div 1{\cdot}324) = {\cdot}524$, a slip of 52·4 per cent.; and then $k = {\cdot}05$, the frictional coefficient for his screws c to k; the maximum efficiency is then obtained for a slip ratio $s = \sqrt{k}$, in this case ·224, or a slip of 22·4 per cent.

In these experiments the rotation of the model screw, about 14·5in. in diameter, caused the water in the tank to circulate, so that the velocity of feed depended on the revolutions of the screw. We think it would be a great improvement in subsequent experiments if the speed of feed could be varied independently. In this manner the problem as presented in practice could be more closely imitated.

For in the design of a propeller for an actual ship the first thing given is the projected speed v, and thence from an examination of the lines of the vessel we can get an idea of the value of u, the mean speed of the wake past the stern-post, which is the speed of feed of the propeller: it is of the greatest importance that u should be known as accurately as possible. Next the draught of water limits d, the diameter of the propeller, and A, the disc area, so that we are left finally with n, the revolutions, and p, the pitch, to adjust, so as to obtain the most economical result for the requisite thrust T of propulsion, which is attained when e, the efficiency—namely, the ratio of thrust horse-power to indicated horse-power—is a maximum.

The thrust horse-power T.H.P. = $T\,v \div 33{,}000$, while the indicated horse-power I.H.P. = $2\pi L n \div 33{,}000$, and, therefore,

$$e = \frac{T\,v}{2\pi L n} = \frac{v}{n\,p} = 1 - \sigma, \text{ or } e + \sigma = 1 \quad . \quad (A)$$

where σ denotes the apparent slip.

For negative apparent slip this would make e greater than unity, which is physically impossible, until we notice that negative apparent slip implies a great waste of power in dragging a wake current, which power must be subtracted from the T.H.P.

A certain amount of wake velocity being unavoidable in any case, there is a gain of efficiency in the propeller by bringing it as close as possible to the vessel to work in this wake, although, on the other hand, the thrust deduction due to the sucking action of the propeller on the stem of the vessel, equivalent to an "augmentation" of resistance on the bow, is increased by bringing the propeller close to the vessel; so that in practice we must balance these causes against each other to obtain the most favourable result. Mr. Froude has pointed out that this augmentation of resistance will sometimes increase the net resistance by about 40 per cent.; in Mr. Isherwood's experiments it amounted to nearly 20 per cent.

Prop. VI.—"The thrust T of any screw working with a velocity of advance V and a slip S can be approximately determined from the equation $T = C\,A\,V\,S\,\gamma \div g$, A being the disc area of the screw, γ the density of water, and C a modulus depending on the pitch and surface ratios of the screw," must be taken as true only for a smooth screw, or approximately for a screw working with a great slip, and then from (3) or (4) we notice that C should vary inversely as the square of the pitch ratio.

Besides the results of his own experiments given in Tables II., V., VI., VII., VIII., X., XI., Mr. Blechynden has analysed the results of Mr. Isherwood's experiments in Tables I., III., IV., IX., and has also given a diagram of the results of Mr. Sydney Barnaby's experiments, with a screw of 9in. diameter, and pitch increasing from 9·42in. to 11·14in., but we notice a misprint of 930 revolutions in the text and in the Table for what is more likely to be 430 revolutions, as the speed of the launch employed by Mr. Barnaby was between 4 and $4\frac{1}{2}$ knots ("Marine Propellers," p. 54).

Prop. VII.—"The effect of surface is the same irrespective of the number of blades into which it is divided so long as it is similarly distributed," should now be incorporated with Prop. I.; then should follow Props. V. and VI., and II., III., IV., may be omitted as unnecessary.

Mr. Blechynden only once falls into the incorrect expression, although a very common one, of speaking of speed in "knots per hour." A knot is never used at sea as a unit of distance, but always as a cosmopolitan unit of speed, the unit of distance being a nautical mile, equal to one minute of latitude on the earth's surface; while a speed of V knots—*nœuds* in French, *knoten* in German, *nodi* in Italian, &c.—means V nautical miles an hour. If while the sand-glass runs half a minute, V knots of the log line pass over the taffrail, the ship is said to be going V knots, and the distance between the knots should be a trifle over 50ft., taking the nautical mile as 6086ft., so that roughly speaking a knot is a velocity of 100ft. a minute; more accurately 101ft. a minute. Mr. Isherwood is careful in his measurements to express velocities in geographical miles of 6086ft. per hour, when he might have used the convenient term "knot."

If the French scientific authorities for the invention of the metric system in their enthusiasm for decimals had not foolishly abandoned the sexesimal for the centesimal divisions of degrees, the quadrant of the earth would have been divided into 90 × 60 instead of 100 × 100 nautical miles, or kilometres, and then the fathom would have with very slight alteration become the metre, and a knot exactly 100ft. a minute.

The metric system and the centesimal division of the angle have never been used in navigation, because a corresponding centesimal measurement of time would be requisite in the conversion of longitude, and this was felt to be too fundamental a change to be made by the originators of the metric system.

"Varying pitches." By making the pitch p of the leading edge of the screw such that its speed of advance $n\,p$ is equal to u, the velocity of feed, we do away with the shock at the leading edge, as in a turbine; and then if the pitch is increased axially to any final magnitude, the effective pitch should be taken as the harmonic mean of the initial and final pitch, but the arithmetic mean is so little different that it is usually taken in practice. Then if e denotes the efficiency and s the slip calculated from the final pitch, we shall find $e + \frac{1}{2} s = 1$, so that there is a considerable gain of efficiency with the properly increasing pitch.

"Curvature of developing surface," &c., does not appear to have much effect in the models, but suitable curvature of the blades may prove useful in cases where the screw works very close to the vessel.

"Fluid friction on blades and edge resistances" still requires much more experimental investigation, and we hope Mr. Blechynden will undertake this task. Considering the comparatively small percentage of slip with which a screw generally works, in general less than 20 per cent., a small alteration in the velocity of the speed on the calculated effect of friction has an important effect on the thrust and I.H.P. To ensure a careful adjustment of the feed, it might be found desirable to work the model screws in a closed tube, as in Mr. Thornycroft's turbine propellers applied to the Nile patrol steamers, and then a careful observation of the slip at which the thrust is just zero, and at which the thrust is a maximum, would give valuable information concerning the effect of fluid friction.

Mr. Blechynden calls attention to the gain of efficiency in making the screw work in the wake, against which must be set off the loss of efficiency due to the increased augmentation of resistance due to the sucking action of the screw on the vessel. In all calculations concerning actual propellers, the speed of the wake should be carefully measured by means of a screw current meter just in front of the propeller, in order that the real slip ratio should be definitely known.

Mr. Blechynden's paper concludes with some valuable considerations on efficiency of propulsion, showing how the considerable latitude permissible in the design of screws allows us to vary the conditions in favour of economy of prime cost, of fuel, of weight, &c., according to the ruling requirements. Carefully drawn diagrams at the end illustrate graphically the reasoning of his paper.

The propositions of Mr. Blechynden's paper, the series of five propositions given by Mr. R. E. Froude in the "Trans." I.N.A., 1886, and the diagrams of Mr. Sydney Barnaby's book on "Marine Propellers," are sufficient for comparative purposes, where, knowing the performance of one screw, we are required to predict the performance of another screw; but the measurement of the absolute values for a standard screw are still uncertain, and it is to be hoped that Mr. Blechynden will undertake this measurement in a subsequent investigation, as the results will be of great use for future designers; just as the measurements of Mr. Bashforth of the resistance of the air to 3in. and 6in. projectiles enable us to calculate the trajectories of small arm bullets and of the projectiles of the largest artillery, and consequently to save the country a considerable gunpowder bill.

ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS.

Spain—Trade of Bilbao in 1886.—British trade with this port has increased since the new treaty with Spain came into force, but the indirect effects of the treaty are remarkable as regards German imports, which have enormously fallen off during the past year; and if British manufacturers supplied their goods on the system adopted by foreign competitors, namely, duty paid, through suitable representatives in the country, authorised to sell and concede credit, they would probably find ready markets for their consignments. They should also, by careful observation and close attention to all the details as to the nature and quality of the goods they send, endeavour to adapt their consignments to the nature of the place; otherwise their goods are liable to be left on account, questions arise, and as legal redress is almost impossible, owing to the expensive and tardy nature of the proceedings, loss and want of confidence are the almost inevitable results. The general effect of the alteration of the tariff under the new treaty between Great Britain and Spain, as far as this port is concerned, has been a marked increase in the importation of many articles of British manufacture and produce which had been so long exposed to unfair competition with countries possessing more favourable treaties. Much remains to be done by the British traders to regain supremacy, or at least an equal share with other countries of the Spanish trade. The great Anglo-Spanish mercantile houses, with longer established agencies and connections throughout Spain, have ample means at their disposal for maintaining and pushing their business; but the vast number of smaller British traders have still to learn the lesson, so well understood by their foreign competitors, that all the advertising, circulars, journals, pamphlets, and letters of inquiry, with which the British consulates in Spain are deluged, will never enable them to compete with the economical, intelligent French and German commercial travellers, who are thoroughly acquainted with the customs, language, manners, and wants of the people among whom they spread in large numbers. Moreover, the British trader, in dealing directly with the native trader, is constantly exposed to losses which probably far exceed the expenses attendant on the employment of competent and trustworthy travellers, who through false economy are not employed.

Spain—Trade of Cadiz and Province of Andalusia in 1886.—The commercial convention of August 11th last, between Great Britain and Spain, will eventually lead to a revival of British trade direct with this country, but it depends on the energy of British manufacturers and merchants to bring this about at an early date. British manufactured goods were not altogether excluded from this market by reason of the additional duties chargeable on them *per se*. The additional duties were avoided by their being introduced into this country through France and Germany, and cleared through the Custom-houses as the manufactures of those countries respectively. These British manufactures reached the merchants of this country at an enhanced price, the commission or profit of the French or German house being added to the original cost. This fact leads to the belief that there will be an immediate transfer of this trade to Great Britain direct, but this greatly depends on the activity and energy of the British manufacturers themselves. The Spanish people are slow to adopt new ideas and to open up new markets, and the British manufacturers must follow the example of their French and German competitors, by sending agents or travellers to ascertain the requirements and wants of the people, and to assiduously push their trade. It may be advanced that it would not pay for each manufacturer to send a traveller abroad, but a number could easily combine for the purpose, and have sample rooms at the principal foreign markets where British trade languishes. Heretofore the habits and tastes of foreign nations have not been sufficiently studied by British manufacturers, the prominent idea being that what is approved of and found saleable in England ought to meet with universal acceptation. This is a fallacy which has injuriously affected British trade. Other nations—France and Germany especially—have studied the requirements and taste of each particular country, and have reaped their reward in a greatly extended trade. The British manufacturer will experience the same benefit when he will recognise the fact that what is admired in Manchester may be viewed with indifference in Madrid, and what is considered good taste in Coventry may be found unsaleable in Cadiz. These remarks have a wide application, and the establishment of commercial museums at the centres of the great manufacturing districts of Great Britain would be of essential service to trade, as showing the character and class of goods necessary to meet the demands of the various foreign countries.

Spain—Trade of Canary Islands in 1886.—Importations which were in former years almost all from England greatly decreased in English manufactured goods; while there was a considerable increase in imports from Germany. German houses send out to this market, as agents, clever linguists, who make it their business, by associating with the makers, to get to know exactly their requirements and tastes. They thus get up novelties and offer very advantageous prices. Advertisements, catalogues, and price lists of every kind, although well and carefully got up, illustrated, and every publicity given to them here, are but little read by the majority of the tradespeople. The English language being very little known in these islands, I would suggest that "they be translated into the Spanish language, or at all events accompanied by a translation." Letters are frequently received from merchants in England desirous of opening business connections with those islands, and asking for the names of firms for the sale of their machines and tools. There is scarcely any sale for machinery here; agricultural machinery as understood in Europe being almost unknown, and imports of engineering and marine machines are not made.

Spain—Trade of Gijon in 1886.—Germany is now the largest importer. The growing increase of German imports deserves especial attention, with a view to get at the secret of their success. The only conclusion to be arrived at is that it consists in their superior organisation for business purposes, with agents on the spot to give every facility and information to consumers. It would be well if our firms could improve, if possible, on the German lines of doing business with Spain and other countries. A knowledge of the daily wants of companies, governments, private firms, and public bodies, throughout the world, would be desirable, with samples, specifications, and conditions of contracts; to obtain this manufacturers would have to combine to establish a "foreign department" at some central point, say Birmingham or London, where daily reports of all contracts and tenders issued by Governments, municipal bodies, harbour trusts, and the heads of private firms could be inspected. The desirable information could be supplied by agents whose duty it would be to send the earliest information of all requirements in the district, with all publications treating of tenders for public works. Thus the manufacturers of the United Kingdom would be in possession of the world's daily wants, with samples of articles required, which would form an interesting exhibition of practical importance. Some such scheme as the foregoing would ensure us a large share of the world's trade.

Spain—Native manufactures of the Philippine Islands.—The report is accompanied with a parcel containing samples of some of the textile fabrics manufactured in the Philippine Islands. Through the introduction of English imitations of many of the articles sent, native industry is fast dying out. With regard to the extension of British trade, a consul cannot do much to push trade. There is also a point which has not received quite so much attention as it deserves, namely, that as far as my observation goes trade at the present time not only does not require pushing, but is overpushed. We have too many commission agents, manufacturers, merchants, lines of steamers, and other means of transit for us to enjoy the advantages of profitable trade. In former years the British merchant with capital at his back had, in many cases, practically a monopoly of the most lucrative business at his port of residence. Such instances are now rare. The extension of pushing for orders by enabling men to start in business without capital, and the establishment of telegraphic communication with the most remote corners of the earth, which penetrates mercantile speculation to so great an extent, have done much to increase competition, and as a necessary consequence, to diminish the margin of profit until it sometimes almost disappears. These remarks refer chiefly to old-established centres, and of course the case is entirely different in a country newly opened to foreign trade. I entirely agree with the opinion that an intelligent expert sent to study on the spot the requirements of any particular locality is the proper means for manufacturers to adopt when they desire to extend their business.

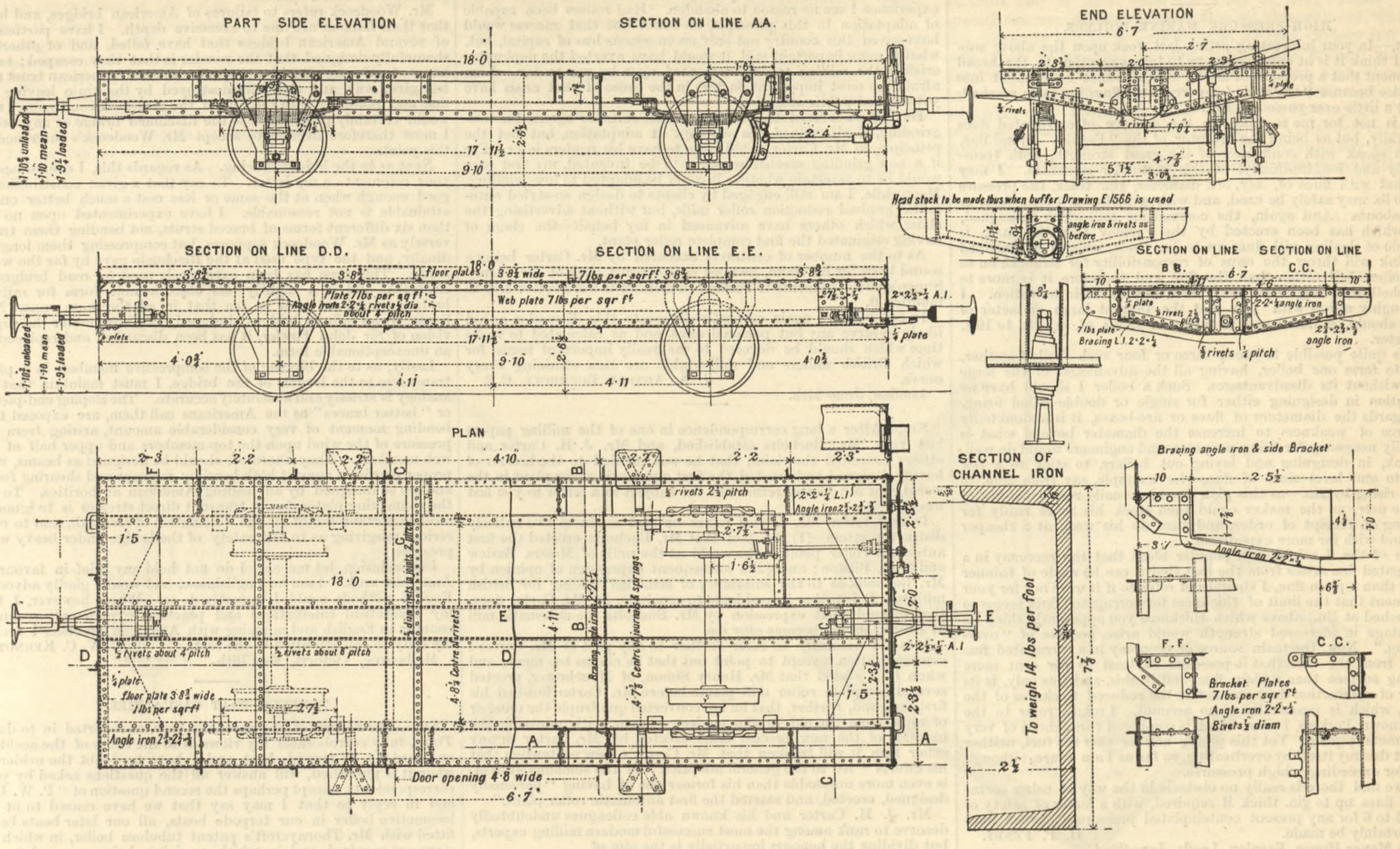
Sweden—Trade of Gothenberg and district for 1886.—During the year 1886 there was less activity in the shipping and trade of Gothenberg than in the preceding year, owing to the depressed state of trade both here and abroad. To this limited activity and unsatisfactory state must be added failures in the country, causing considerable loss, in consequence of which greater caution was required, and sales restricted. At the opening of the year the prospects of the Swedish iron trade, and business connected therewith, were rather gloomy. The prices which at the beginning of the year were about £8 10s. 8d. per ton for hammered iron, £8 4s. for rolled iron, and £8 13s. 4d. for nail rods, declined further during the spring and summer, when the iron trade was exceptionally dull, and during the autumn the quotations, were £7 17s. 4d., £7 12s., and £7 16s. per ton, respectively, prices which doubtless were attended with a loss to ironmasters. This state of the trade has been caused by a steady falling off in prices since February, 1880. A declination of so long duration has had the effect of compelling buyers to limit requirements to what was unavoidable, and of checking speculation. Pig iron has shared in the general depression, and gone down from £3 17s. 4d. per ton on truck here. Steel in kegs has, in consequence of the new processes, Bessemer and Martin, almost gone out of demand; the same state of things prevails in regard to hand-made nails, which cannot compete with the machine-made. The import of English and Scotch pig iron is annually increasing, more especially in consequence of the very low prices. Large section rails are now being manufactured in the country, the State railway having contracted for 31,000 tons to be delivered during the years 1887-92 at an average price of £5 16s. 2d. per ton, which will lessen the import from Germany and Great Britain. Small section rails are imported from Belgium and Great Britain, principally from the former country. Old rails are appropriated for the manufacture of angle fish-plates, which are gradually coming more in use than the trapeze-shaped fish-plates. Dairy machinery is chiefly made in the country. The import of agricultural implements and machinery have decreased on account of improved native make. The same remark may be applied to wood, drilling, grooving, punching and washing machinery, engines—portable and stationary—belting, while boilers, girders, pipes, pumps, tubes, &c., continue as hitherto to be imported from Belgium, Germany, and Great Britain—chiefly from the latter country. The import of coal has been about equal to that of 1885. There is a marked augmentation in the consumption of house coal. Attempts to find a market here for Westphalian house coal have, in consequence of high prices and inferior quality, not been successful. On the other hand, foundry coke from England has been much supplanted by the Westphalian washed patent coke, which, although not much cheaper, is pronounced by consumers to contain less sulphur than the English coke. From the English gasworks, especially those of London, there has been a large import in consequence of the continually increasing consumption of house coke, both here and in the country; and although the gasworks here sell at lower prices, the English coke is preferable, being of greater strength or heating power. The production of native coal has gradually increased from 48,130 tons in 1872 to 166,276 tons in 1885, and is mostly used for consumption in the neighbouring fireclay works, &c.

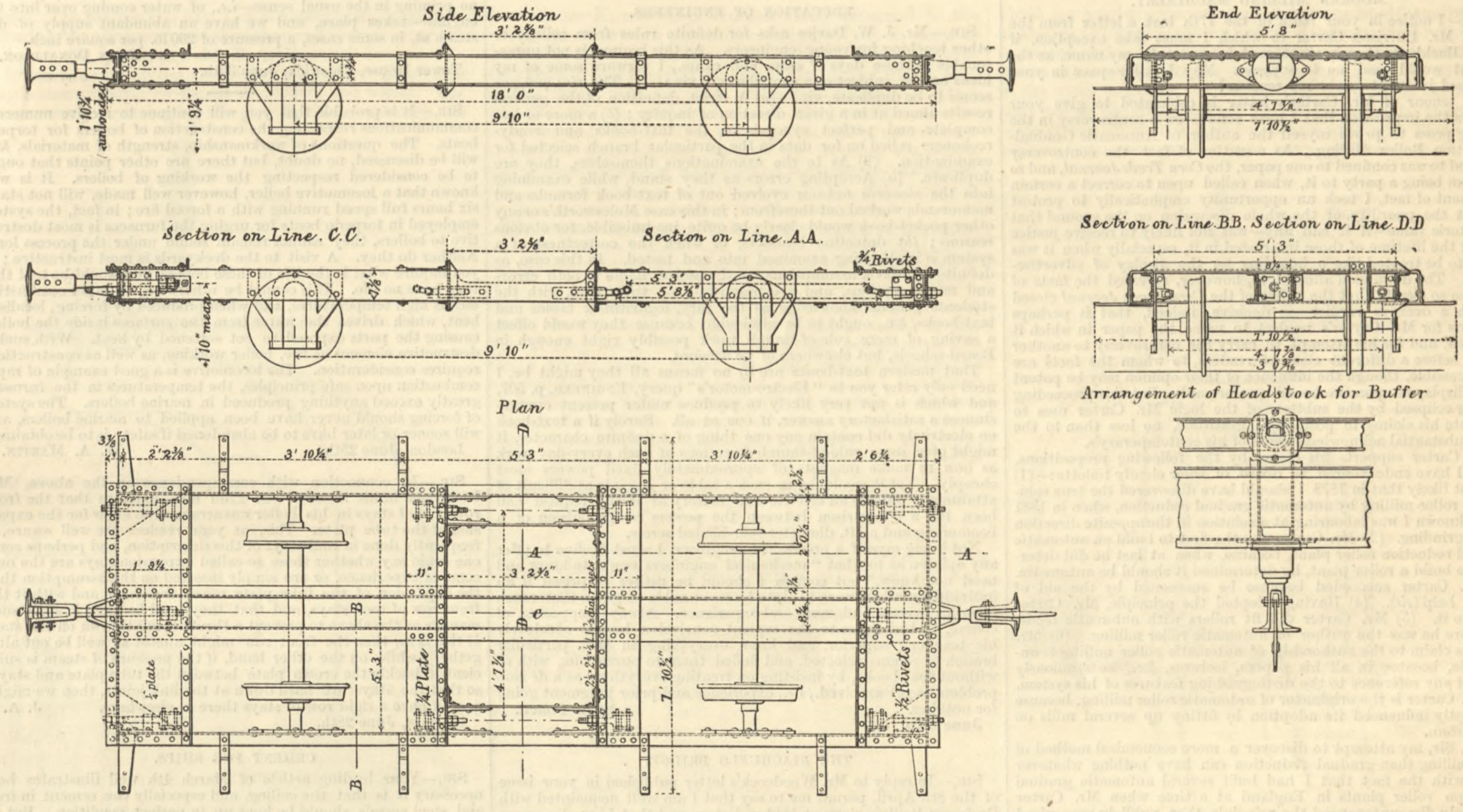
Turkey—Trade of Trebizond in 1886.—The import trade at Trebizond, Samsoon, and other parts shows for the Anatolian markets a decrease in weight, and an increase in value, while the contrary is manifested in the transit imports for Persia. The increased importation of copper in 1886 at cheaper prices and lower freights enabled the local merchants to export with profit, quantities of it to Batoum during the time preceding its abolition as a free port. The remaining stock is still beyond the requirements of these markets, so that its imports in 1887 are not likely to be great. British steamship companies will do well to send their boats to these parts with greater regularity. Dates of their departure from the United Kingdom should be invariably fixed for a convenient number of years, and their destination clearly notified to the public at large, both abroad and at home. The carrying out of these suggestions is rendered advisable by the fact that the import cargoes by British steamers at Trebizond during 1886 figure only as £29,420 from England, and £10,106 from other countries, out of a total of £1,673,265, of which £837,135 are British imports; while the exports by English steamers amounted to Great Britain to £22,300, and to other countries to £17,510 out of a total of £531,860, of which £48,930 represents the exports to the United Kingdom. At Samsoon the anomaly is more striking, for out of a total of £687,820, £471,030 represents the British imports, of which £8000 only were brought by British steamers, while in exports out of £666,130, £143,610 were sent to the United Kingdom, £35,000 of which were the value of the cargoes in British steamers. British trade would no doubt greatly develope by commercial travellers visiting the country with samples, studying the requirements of the people, and meeting local tastes in the nature, quality, and value of the goods most in demand. The three to six months' credit afforded in business transactions to natives by European merchants is not to be recommended. The English system of cash terms, though inconvenient to local tradesmen, is far more preferable, and may—if other facilities are afforded—cope successfully with the money concessions of Austria, France, and Germany.

Brazil: Trade of Santos in 1886.—The normal value of the imports into this province from Great Britain during recent years averages about £600,000 per annum on an increasing scale; but this amount may in any year increase by several hundred thousand pounds, when any new railroad or other enterprise requiring material, plant, or rolling stock is started. Such works are always more or less in course of initiation or construction in this flourishing province. In addition to the complete transfer of the earthenware and glass trades from Great Britain to Germany, the cutlery and steel ware industries have been similarly menaced. A large firm of German importers in Sao Paulo recently imported a large assortment of German cutlery and distributed it about the interior towns of the province. These German goods, though inferior to British in finish and quality, practically answer the same purpose, and are about 75 per cent. cheaper. The retail shops found an exclusive and ready demand for these articles, and large consignments are ordered from Germany, to the exclusion of British cutlery. In this province foreign competition has made but slight impression on the general course of British trade. The Germans have possessed themselves of one or two branches, and are making great efforts to establish the supremacy of others in this market. For the British manufacturer to hold his own can only be assured by the concerted action of all the commercial and industrial classes on well organised principles of trade. By the production of wares which excel in quality and undersell the opposition, while gaining the acceptance and preference of the markets; old routine should be abandoned and new methods of design and supply adopted to meet the varying demands of foreign trade, tastes, and local option. A keen interest in, and knowledge of, British productions should always be kept alive by a constant and sharp trade propaganda carried on either by competent and well trained commercial travellers or wisely distributed commercial agencies. In this province probably the German is the only serious rival in the field, and British industries have not much to fear from other competition. German goods in many instances equal those of Great Britain in quality, and are always lower in price. Apart from these, a great secret of German success is their thorough training as mercantile men. German merchants abroad are shrewd hard-working men, generally of ample education and agreeable social qualities, broad unprejudiced views, with the gift of ingratiating themselves with the people among whom they reside and have to deal. In such men the German manufacturer finds solid support and the most potent means for the extension of trade. Of all the suggestions yet made for the extension of British trade, perhaps none would be more productive of practical results than the establishment of commercial and industrial agencies or museums at certain advantageous localities abroad primarily in new countries. Such agencies to be under the management of at least two persons, experts in the principal branches of British trade and of large commercial experience. One man to be for indoor service, and the other for travelling through the district and keeping up a constant trade propaganda. In these days of competition trade must be active and aggressive. By such a method local merchants and tradesmen would acquire a more extended knowledge of British productions, might be placed in ready contact with home producers, and led to establish more direct and intimate commercial relations with Great Britain.

THE ALUMINIUM COMPANY, LIMITED.—Under this title a company is being formed for producing cheap aluminium by the aid of the sodium process, fully described in our last impression. The proposed capital is £400,000 in 60,000 shares. An excellent board of directors has been formed, including, among others, Mr. W. Anderson, M. Inst. C.E., General Sir Andrew Clarke, R.E. and Sir H. Roscoe, F.R.S.

CONTRACTS OPEN.—UNDERFRAMES AND COVERED WAGONS FOR INDIAN STATE RAILWAYS.





CONTRACTS OPEN.

INDIAN STATE RAILWAYS—UNDERFRAMES FOR THIRD-CLASS CARRIAGES AND COVERED GOODS WAGONS.

THE work required under this contract comprises the construction, supply, and delivery, f.o.b. London, Liverpool, or other ports in England, of underframes, steel and iron work for underframes, with all requisite bolts and nuts, washers, rivets, and iron wood-screws complete, for putting the work together in India, for ten underframes for third-class carriages, 18ft. long, with screw buffer at one end, and buffer with hook rivetted in at the other. One hundred underframes for covered goods wagons, 18ft. long, with buffers, with pin, chain, and vice handle attachment at one end, and buffer with hook rivetted in at the other. All fastenings, screws, bolts and nuts, rivets, and washers are to be supplied in quantities sufficient for putting all the work together in India, with an allowance of 20 per cent. extra for waste. The contract does not include wheels and axles, bearing, draw, and buffer springs, and axle-boxes. All these parts will form the subjects of separate contracts. No woodwork is required to be sent to India. Tenders, addressed to the Secretary of State for India in Council, with the words "Tender for underframes for carriages and wagons" on the envelope, must be delivered at the India-office, Whitehall, London, S.W., before 2 p.m. on Tuesday, July 5th, 1887. If delivered by hand, they are to be placed in a box provided for that purpose in the Store Department.

HARWICH AND DOVERCOURT WATER SUPPLY.—It will hardly be believed, but it is a fact that Harwich has now what may be called a water supply. A Harwich and Dovercourt water-supply was opened, it need hardly be said with considerable rejoicing, last week. The most important feature in the Jubilee celebration at Harwich, on Wednesday, was the formal opening of a supply of pure water, the want of which has so long pressed upon the inhabitants of the neighbourhood. Harwich and Dovercourt may now be congratulated upon receiving in this Jubilee year such an essential benefit to life and health, especially needed. Down to the early part of this century the inhabitants of the town and the shipping frequenting the harbour had to depend upon such precarious and at best dubious supplies as could be obtained from the storage of rain water from house-tops, spring water brought down in wherries or barges from Ipswich or Mistley, and the yield of a few local shallow wells. In 1819 an Act was obtained for the appointment of Commissioners for paving, lighting, and watering the town, with general provisions for such purposes. Boring into the chalk in search of water was resorted to in 1820-22, in 1826, and again about the year 1840. In 1854 Mr. P. Bruff, the engineer for the works under the Commissioners' "Improvement Quays and Pier Act, 1851," entered into an agreement—May 16th, 1854—with the Corporation, by which the Corporation granted him the exclusive concession of the water supply for seventy-five years. After various unsuccessful efforts to accomplish what was required, and an extension of the limit of time in such agreement, the chalk and underlying strata were pierced to the depth of 1098ft., when a hard slaty rock was encountered, and proceedings were then suspended without obtaining any water whatever. In 1862 the agreement was revised and extended, and Mr. Bruff obtained a supply of water at Dovercourt by means of a well and artesian boring, and commenced supplying the town and borough in 1865-6, and has since continued to do so. Although limited in quantity, and not all that could be desired in quality, there is a considerable excess of chlorine in its composition. In 1881, in order to meet the requirements of the Public Health Act, 1875, application was made to the Board of Trade, and in 1884 and 1886 applications were made to Parliament to authorise works to be established at Bradfield and Mistley, and Acts of Incorporation were obtained by the Tendring Hundred Waterworks Company, after considerable opposition, a previous application in 1883 having failed. A site having been acquired at Mistley, a capacious well and boring into the chalk were made, from which the present good supply of water is obtained. Buildings have been erected at Mistley, and duplicate engines and pumps fixed, and a main is laid to Harwich, a distance of about twelve miles, and in addition the company have acquired the existing works at Harwich, Dovercourt, and Walton-on-the-Naze, as well as valuable sites for enlargement of works and establishment of reservoirs at Bradfield and Dovercourt, and by arrangement with the Great Eastern Railway Company, expect to have a site placed at their disposal for a similar facility at Parkeston, for the use of that locality. The well and the pipe line were executed by Messrs. T. Tilley and Son, London

LETTERS TO THE EDITOR.

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

HIGH-PRESSURE MARINE BOILERS.

SIR,—In your interesting article last week upon the above subject I think it is at once necessary to take exception to the broad statement that a pressure of 250 lb. at sea cannot be brought into practice because "the limit for corrugated flues has been reached, if not a little over-passed at 160 lb."

It is not for me to take up the defence of corrugated flues generally, but as being the inventor of the "Farnley" spiral flue, I can speak with confidence of the great strength, both transversely and longitudinally, of this particular structure. I may say that with flues of, say, 3ft. diameter, ½in. thick, the pressure of 250 lb. may safely be used, and with a factor of 4 for safety, or thereabouts. And again, the corrugating mill which I designed, and which has been erected by the Farnley Iron Company, is capable of dealing with flues up to ⅝in. thick, which I am inclined to think will throw the onus of responsibility for strength on to the boiler shell rather than the flue, and therefore it is more to the shell that engineers must now devote their attention. I thoroughly agree with you that the present large diameter of shells should be abandoned in favour of shells, of, say 8ft. to 10ft. diameter.

It is quite possible to group three or four such shells together, so as to form one boiler, having all the advantages of the large shell without its disadvantages. Such a boiler I should have no hesitation in designing either for single or double-ended firing. As regards the diameters of flues or fire-boxes, it is undoubtedly a source of weakness to increase the diameter beyond what is actually necessary for firing purposes, and engineers would do well, I think, in designing and laying out boilers, to stick to a few definite and level sizes of flues—for example, say from 28in. to 42in., rising by 2in.—as this plan would actually result in a saving to the user, as the maker could then stock his tubes ready for flanging on receipt of order, and thus do his work at a cheaper rate and with far more expedition.

One of the, I might say, popular ideas that the economy in a corrugated flue arises from the fact that it can be made of thinner metal than a plain flue, I should not refer to if it were not for your statement that the limit of thickness for corrugated flues seems to be reached at ½in., above which thickness you apparently think no advantage in increased strength would arise, because of "overheating." Now, the main source of economy in a corrugated flue arises from the fact that it possesses at least 25 per cent. more heating surface than a plain flue, and to this, and this only, is its power of conduction due, and not to the reduced thickness of the metal, which is practically of no account. I might refer to the well-known Perkins boiler, which is composed throughout of very thick metal piping. Yet this piping neither eats the fuel, neither does it destroy itself by overheating, so far as I am aware, although used for exceedingly high pressures.

So we find there is really no obstacle in the way of using corrugated flues up to ⅝in. thick if required, with a factor of safety of from 4 to 6 for any present contemplated pressure, and such flues can certainly be made. H. P. FENBY.

The Manor House, Farnley, Leeds, June 22nd.

MODERN MILLING MACHINERY.

SIR,—I notice in your issue of the 17th inst. a letter from the pen of Mr. Harrison Carter to which I must take exception, if G. A. Buckholtz therein mentioned is meant for my name, as the context would lead me to suppose. May I claim space in your esteemed journal to state my reasons?

The tenour of Mr. Carter's letter is calculated to give your readers the impression that I have conducted a controversy in the milling press to prove myself the author of Automatic Gradual-Reduction Roller Milling. As a matter of fact the controversy referred to was confined to one paper, the *Corn Trade Journal*, and so far from being a party to it, when called upon to correct a certain statement of fact, I took an opportunity emphatically to protest against the puerility of the whole discussion on the ground that its historic value—if it had any—was not likely to receive justice during the lifetime of those interested in it, especially when it was likely to be treated like a hoarding for the display of advertisements. The discussion alluded to, however, revealed the facts of the case so clearly that the editor of the *Corn Trade Journal* closed it with a decisive verdict—so decisive, indeed, that it perhaps accounts for Mr. Carter's neglect to name the paper in which it occurred, and for his attempt to carry the controversy to another arena, before a different class of readers, to whom the facts are less accessible, though the influence of their opinion may be potent when displayed upon the hoarding aforesaid. But this proceeding is quite eclipsed by the subtlety of the logic Mr. Carter uses to vindicate his claims to posterity's gratitude, no less than to the more substantial acknowledgments of his contemporary's.

Mr. Carter supports his claim by the following propositions, which I have endeavoured to divest of their cloudy toilette:—(1) It is not likely that in 1878 I should have discovered the true solution of roller milling by automatic gradual reduction, when in 1881 it was known I was labouring at a solution in the opposite direction of low grinding. (2) Mr. Carter was the first to build an automatic gradual reduction roller plant, because, when at last he did determine to build a roller plant, he determined it should be automatic. (3) Mr. Carter succeeded because he succeeded by the aid of willing help (*sic*). (4) Having adopted the principle, Mr. Carter stuck to it. (5) Mr. Carter did fit rollers with automatic feeds, therefore he was the author of automatic roller milling. (6) Mr. Carter's claim to the authorship of automatic roller milling is undeniable, because in all his papers, lectures, &c., he studiously avoided any reference to the distinguishing features of his system. (7) Mr. Carter is the originator of automatic roller milling, because he greatly influenced its adoption by fitting up several mills on that system.

Now, Sir, my attempt to discover a more economical method of roller milling than gradual reduction can have nothing whatever to do with the fact that I had built several automatic gradual reduction roller plants in England at a time when Mr. Carter absolutely discountenanced the principle then publicly recognised by me—viz., that all the grinding operations in a flour mill can be conducted more efficiently by a pair of rollers than by a pair of stones, and that it was not until a considerable time after the success of my mills was fully established that Mr. Carter built his first complete roller mill in Dublin.

The resolve to make his first roller plant automatic, put forth as a basis to claim the authorship of the process, is only less singular than Mr. Carter's paraphrase of the old saw, "Nothing succeeds like success," also advanced in support of his claim. What about Mr. Henry Simon's claims? Or does Mr. Carter seriously deny that, to all intents and purposes, Mr. H. Simon had anticipated him by the erection of an automatic gradual reduction plant?

But the most edifying prop to his claim exhibited by Mr. Carter is that of virtue—viz., his fidelity to principle—a sly side-hit at some of us supposed to be less virtuous. Surely Mr. Carter will withdraw the taunt when he takes the trouble to consider the following facts?

All the gradual reduction plants in this country are mere compromises with the principle of gradual reduction, each mill being designed to adapt only so much of the principle as happens to meet the requirements of the millers' circumstances. In no case are the principles of gradual reduction applied as fully or carried out as consistently as abroad—in Hungary, for instance.

Now, the same reasons which induce every millwright to compromise whenever he designs a mill for this country induced me to pursue the principle of low-grinding as adapted to rollers—a principle which, under the new name, "short system," to save appearances, has lately found many devotees. This principle implies that for a given yield in flour and a given grinding mechanism the fewest number of grindings will result in a better quality of flour than gradual reduction—a principle which after the most varied experience I see no reason to abandon. Had rollers been capable of adaptation to this principle, no doubt but that success would have saved this country not only an enormous loss of capital, but, what is more important still, it would have averted the deplorable crisis in the milling trade commented upon by you to-day. I am afraid the most important factors in the cause of that crisis have yet escaped public attention.

Having discovered that rollers are not suitable agents for low-grinding, I abandoned the attempt at adaptation, but not the principle, as Mr. Carter would seem to have his readers infer. For if a new grinding mechanism were to be invented, my first care would be to ascertain whether it could be adapted to low-grinding. Meanwhile, I am still engaged by clients to design so-styled automatic gradual reduction roller mills, but without advertising the claim which others have advanced in my behalf—the claim of having originated the first complete roller plant.

As to the number of contracts executed by Mr. Carter being a sound basis for his claim, he need only consult some of Mr. Henry Simon's advertisements to become convinced it were better not to mention it.

In conclusion, I again earnestly deprecate this discussion as not likely to serve any but personal aims, and as calculated to waste time which should be devoted to the really important issues for which British millers and millwrights are now straining every nerve. J. A. ARNOLD BUCHHOLZ, C.E.

London, June 24th.

SIR,—After a long correspondence in one of the milling papers last year, Mr. Bucholtz established, and Mr. J. H. Carter and others conceded the claim, that he was entitled to the honour of having designed and erected the first automatic roller plant in the world, but Mr. Carter returns to the subject in a letter to you last week.

In that letter Mr. Carter mixes up and confuses two entirely distinct matters—(1) the fact that Mr. Bucholtz erected the first automatic roller plant in the world at the mills of Messrs. Barlow and Sons, Bilston; and (2) a subsequent expression of opinion by Mr. Bucholtz as to the suitability of semolina milling for British millers. It is rather looped logic to conclude, as Mr. Carter does, that through that expression by Mr. Bucholtz the automatic mill at Bilston should become *alter ego*.

It is not necessary to refer further to any part of Mr. Carter's communication, except to point out that he claims too much, and when it is stated that Mr. Henry Simon, of Manchester, erected several complete roller mill plants before Mr. Carter finished his first one, and, further, that he has converted quadruple the number of mills from the old to the modern system, with quintuple the capacity of the new process mills erected by Mr. Carter or any other firm, it will be seen that Mr. Carter's new contention that his efforts "led to the general adoption" of the semolina system, is even more untenable than his former one of having "personally designed, erected, and started the first automatic roller plant."

Mr. J. H. Carter and his known able colleagues undoubtedly deserve to rank among the most successful modern milling experts, but dividing the honours impartially is the aim of

June 28th. THE WRITER OF THE ARTICLE.

EDUCATION OF ENGINEERS.

SIR,—Mr. J. W. Davies asks for definite rules from college or other teaching for young engineers. As this request is not unreasonable in these days of cram and exam., I forward some of my ideas on the subject as a contribution, viz.:—(1) The *sine quâ non* seems to be duplicate, viz.:—(*a*) A strict definition of the general results aimed at in a given direction of inquiry; (*b*) a more or less complete and perfect synopsis of the text-books and ready-reckoners relied on for data in the particular branch selected for examination. (2) As to the examinations themselves, they are duplicate. (*a*) Accepting errors as they stand, while examining into the *memoria technica* evolved out of text-book formulæ and memoranda worked out therefrom; in this case Molesworth's or any other pocket-book would clearly be quite inadmissible, for obvious reasons; (*b*) detecting blunders, or when the correctness of a system is itself being examined into and tested. In this case, as definite text-book assumptions are themselves liable to both errors and misconceptions, and are practically on their trial, with the students' general knowledge as the jury, logarithmic tables and text-books, &c., ought to be admissible, because they would effect a saving of mere rule-of-thumb work possibly right enough in Board-schools, but elsewhere of no account.

That modern text-books are by no means all they might be, I need only refer you to "Electro-motor's" query, ENGINEER, p. 507, and which is not very likely to produce under present circumstances a satisfactory answer, if one at all. Surely if a text-book on electricity did contain any one thing of a definite character, it might give some rule-of-thumb directions of such every-day work as how to make magnets of approximately fixed powers most cheaply. Yet it would seem such a table or *precis* is as difficult of attainment outside an electric bell factory as if the request had been for a comparison between the powers of propulsion of a boomerang and a 1ft. diameter four-bladed screw.

Not being myself a professional engineer, I must decline to offer any opinion as to what "mechanical engineers ought to know and need not know," but confess I should be rather surprised if an individual student were to state he was unable to guess that much from his private judgment and experience. Always supposing, of course, he had come to the sapient conclusion he was absolutely his teacher's superior, and knew everything in that particular branch of science selected, and defied them to puzzle him, with or without text-books, by insisting on treating everything as a *de novo* problem as yet unsolved., *i.e.*, experience and prior judgment going for nothing. SLOW COACH.

June 28th.

THE RIACHUELO BRIDGE.

SIR,—In reply to Mr. Woodcock's letter published in your issue of the 8th April, permit me to say that I am well acquainted with Professor Reilly's views on bridge design, and that I am also aware that the whippletruss, of which the above bridge is an example, was described by its inventor in 1847, more than twenty years before Professor Reilly's paper in the "Transactions" of the Institute. Bridges of this type are found by hundreds in America, so as, in fact, to form quite a prominent and characteristic feature of American scenery, but I do not know of one of them in England. I therefore must repeat my statement that the type is undeniably American, just as I should unhesitatingly pronounce an outside cylinder locomotive, with bar frame, cast iron wheels, and cow-catcher, to be American.

Next, as to the question of depth. I find by careful and repeated calculation that a depth of one-sixth to one-seventh of the span is highly economical in the case of such a bridge as the Riachuelo. I find that the great American bridge-building companies who have put up whippletrusses by hundreds, if not thousands, who design as well as execute, have for years past adhered to the depth I mention, and find no trouble in erection. I further find that the great Hawkesbury Bridge, near Sydney, the privilege of erecting which was won in open competition with all the world by the Union Company of New York, Sir John Fowler himself endorsing the decision, has girders 410ft. span and 58ft. deep, almost exactly the proportion I advocate, and then I am told by Mr. Woodcock, of whom as a bridge builder I never heard before, that it is all wrong, because he has found in some unexplained way that one-tenth is the correct ratio. Now, whom am I to believe? The American bridge engineers who possess such ample opportunities and such enormous experience, who are so remarkably consistent in their conclusions, and whose practice tallies so closely with my own theoretical deductions, or a gentleman with whose previous work I am unacquainted, and who simply gives an *ex cathedra* opinion.

Mr. Woodcock refers to failures of American bridges, and hints that their failures are due to excessive depth. I have particulars of several American bridges that have failed, and of others so shamefully designed that the wonder is that they escaped; but I know of only one case of a properly designed American truss that has given way, and that was destroyed by the train leaving the line and plunging into the web of the girder—a contingency that would certainly prove fatal to the Riachuelo bridge or any other. I must therefore decline to accept Mr. Woodcock's inference on this point.

Next as to the ladder bracing. As regards this, I cannot accept your comment on my letter. To say that a given construction is good enough when at the same or less cost a much better one is attainable is not reasonable. I have experimented upon no less than six different forms of braced struts, not bending them transversely as Mr. Woodcock supposes, but compressing them longitudinally, and the type used at the Riachuelo gave by far the worst result. This type has been extensively used for road bridges in Australia, and in a slightly less objectionable form for railway bridges; but I am glad to see that in all the more recent New South Wales railway bridges, designed, I believe, under the supervision of Sir John Fowler, it has been discarded, and replaced by an unexceptionable form.

Lastly, as to the bracing of the compressive members in a plane transverse to the length of the bridge, I must maintain that my analogy is strictly and absolutely accurate. The sloping end-pieces, or "batter braces" as the Americans call them, are exposed to a bending moment of very considerable amount, arising from the pressure of the wind upon the top members and upper half of the web members. They therefore should be designed as beams, with proper provision against both bending moment and shearing force, and are so designed by all leading American authorities. To say the connecting plates do not transmit direct stresses is to ignore a most important factor in the calculation of strength, and to raise serious misgiving as to the safety of the bridge under heavy wind pressure.

In conclusion, let me say, I do not hold any brief in favour of American work. I am an Englishman, and would gladly advocate English methods could I honestly do so. When, however, I find my theoretical calculations and practical experiments running counter to English and agreeing with American practice, I feel it my duty to call attention to the fact. W. C. KERNOT.

Melbourne, Victoria, May 16th.

TORPEDO BOAT CASUALTIES.

SIR,—The verdict of the coroner's jury, as reported in to-day's *Times*, fully corroborates my views as to the cause of the accident on board No. 47 torpedo boat, and I have no doubt the evidence, when it is published, will answer all the questions asked by your correspondents, except perhaps the second question of "P. W. D.," and in reply to that I may say that we have ceased to fit the locomotive boiler in our torpedo boats, all our later boats being fitted with Mr. Thornycroft's patent tubulous boiler, in which no stays are required, and in which, no joints being exposed to the direct action of the fire, we have no leakage.

Although the circulation in this boiler is maintained by priming, no priming in the usual sense—*i.e.*, of water coming over into the engines—takes place, and we have an abundant supply of dry steam at, in some cases, a pressure of 200 lb. per square inch.

JOHN DONALDSON.

Tower House, Chiswick, June 30th.

SIR,—It is probable that you will continue to receive numerous communications respecting the construction of boilers for torpedo boats. The questions of workmanship, strength of materials, &c., will be discussed, no doubt, but there are other points that ought to be considered respecting the working of boilers. It is well known that a locomotive boiler, however well made, will not stand six hours full speed running with a forced fire; in fact, the system employed in torpedo boats for urging the furnaces is most destructive to boilers, they cannot remain sound under the process long. Neither do they. A visit to the dockyards is most instructive; if you inquire what is the life of these boilers, you would be told that they have no life. This cannot be otherwise, for rapid combustion means high temperatures, and when produced by forcing, localised heat, which drives the water from the surfaces inside the boiler, causing the parts exposed to get softened by heat. With such a destructive element as fire, boiler working, as well as construction, requires consideration. The locomotive is a good example of rapid combustion upon safe principles, the temperatures in the furnaces greatly exceed anything produced in marine boilers. The system of forcing should never have been applied to marine boilers, and will sooner or later have to be abandoned if safety is to be obtained.

London, June 25th. W. A. MARTIN.

SIR,—In connection with correspondence on the above, Mr. Donaldson in his letter of the 22nd inst. explains that the front row of roof stays in his boiler was arranged to allow for the expansion of the tube plate. This, as your readers are well aware, is frequently done in roof stays of this description, and perhaps some one could say whether those so-called expansion stays are the outcome of experience, or are simply inserted on the assumption that the expansion of the tube plate raises the crown and with it the front row of roof stays, and that they must be fixed in some such manner as the above to prevent a thrust being thrown on the stay. If this is so, then the front row might almost as well be out altogether; while, on the other hand, if the pressure of steam is sufficient to buckle the crown plate between the tube plate and stays, so that the stays are hard down at the link joints, then we might as well have a rigid row of stays there as elsewhere. J. A.

Glasgow, June 28th.

CEMENT FOR SHIPS.

SIR,—Your leading article of March 4th well illustrates how necessary it is that the ceiling, and especially the cement in iron and steel vessels, should be kept up in perfect condition. But as Portland cement when set is so very brittle and liable to crack, does it not appear desirable in light hulls, which spring and vibrate considerably, that the cementing should be of a somewhat elastic and adhesive nature? I have used with success for several years simply quicklime stirred into boiling coal tar for the protection of the bottoms of small steam launches, &c., both of iron and wood. The limbers of wooden launches are much more easily kept clean if filled up to the level of the timbers with something of this kind.

Portland cement makes a most excellent joint on badly-fitting manhole doors, &c., on a steam boiler. E. C. S.

Auckland, N.Z., May 20th.

(*For continuation of Letters see page 18.*)

JUBILEE OF THE ELECTRIC TELEGRAPH.—An influential meeting of telegraph engineers, electricians, and those interested in telegraphy, presided over by Mr. Preece, F.R.S., was held at the Sanctuary, Westminster, on Monday, to determine the necessary steps to celebrate the jubilee of the telegraph. On July 25th, 1837, the first successful essay of a practical telegraph was made by Messrs. Cooke and Wheatstone between Euston and Camden, on the London and North-Western Railway. It was decided to have a dinner to commemorate this event on Wednesday, July 27th, under the chairmanship of the Right Hon. Cecil Raikes, Postmaster-General.

THE NEWCASTLE EXHIBITION.

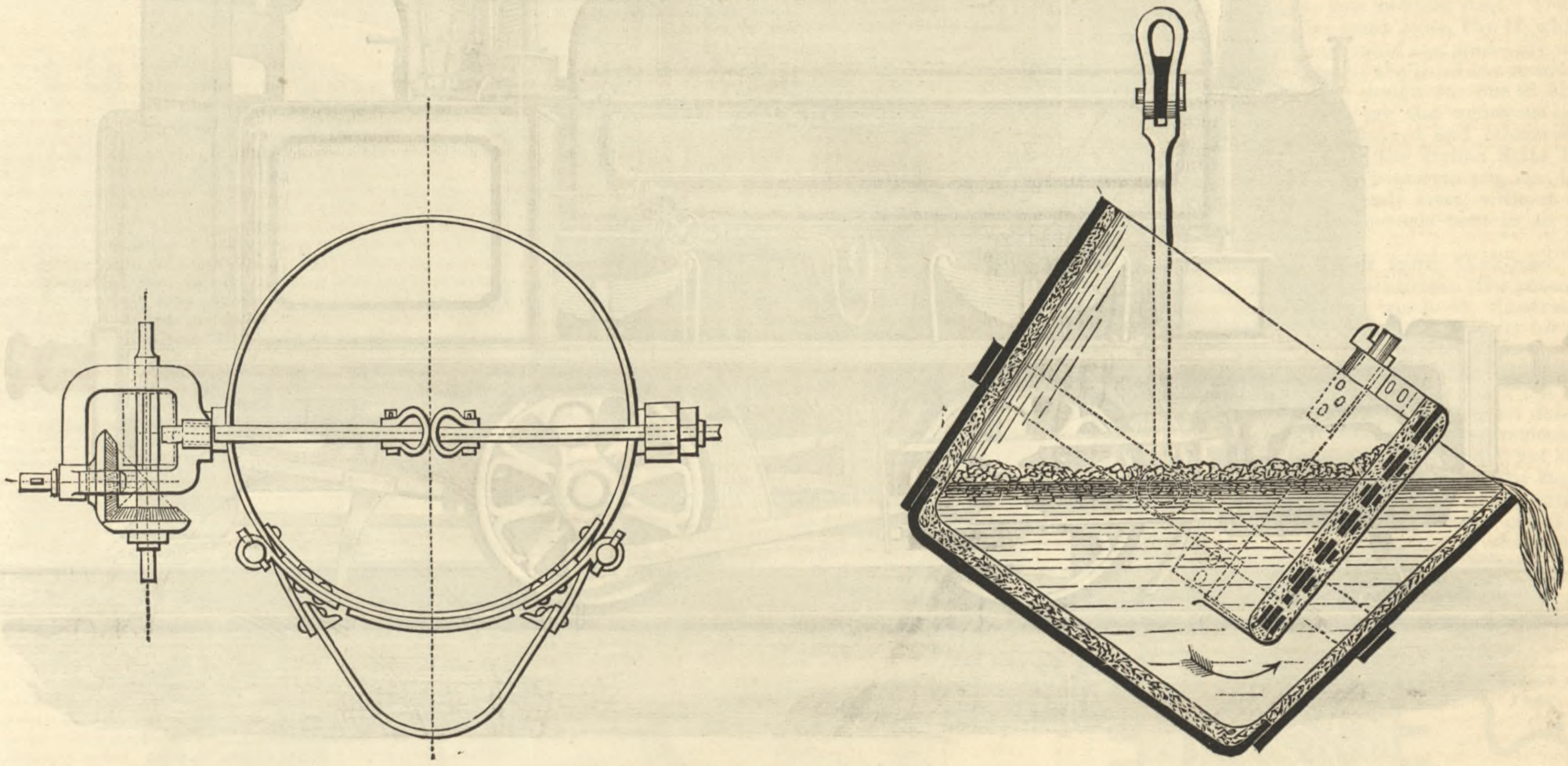
In the description of the large marine boiler exhibited by the Wallsend Slipway and Engineering Company, which appeared in THE ENGINEER of the 27th of May, reference was made to the special methods of construction which had been adopted in order to admit of the rivetting being done by machines instead of by hand. We now illustrate by the engravings below and on p. 7 one of Tweddell, Platt, and Fielding's patent portable plate-closing rivetters, by means of which much of the heavy work was accomplished. The construction of the rivetter is as follows. The main body, Fig. 1, A is a steel casting, one end B forming the abutment and the other end C containing the two hydraulic cylinders. At D a gudgeon is turned, the whole machine revolving on this by the hanger E, motion being communicated by means of a worm and wheel. The pressure water entering by the pipe F, passes through the gudgeon to the valves and cylinders. Screwed into C is a gun metal cylinder H in which works the large ram I, carrying the cupping die J. Inside this, and forming part of the main ram I, is a cylinder K, containing the smaller ram L, to which is fixed the plate-closing die M, this latter being annular and surrounding the cupping-die. Both rams are returned back by means of the constant pressure plunger N working in the cylinder O. The working valves are shown at P, Q being the inlet to the main cylinder, and R that to the smaller one, communication being completed by means of the telescope pipe S.

The mode of working is as follows. Both rams being home, pressure is first admitted to the small ram L carrying the plate-closing tool. This travels forward till it bears on the plates, as shown in dotted lines in the engraving. After the plates are thus brought together, pressure is admitted to the large cylinder, and the large ram I carrying the cupping tool then goes forward. During this movement the pressure is still maintained in the cylinder K, any surplus water being returned to the accumulator through an automatic valve; but as soon as the tool is fairly on the rivet the cylinder K is opened to the exhaust, and the full pressure due to the whole area of the large ram is then utilised in closing. After this the tool is withdrawn, and the machine moved on to the next hole. The pressures actually exerted are 30 tons for plate-closing, 45 tons for forming the rivet, and 75 tons for finally heading and completing the operation. The machine is equal to closing $1\frac{1}{4}$in. steel rivets in $1\frac{1}{16}$in. steel plates, including double butt straps.

The engraving on page 7 shows the seams at the back, between the end plate and shell, and the application of the rivetter. The end plate is flanged the reverse way to usual, so as to get both ends of the rivet outside. The same machine may be used for furnace mouth work. In this case the movable die is attached to the plate-closing ram, which gives sufficient pressure for the size of rivets used; while the large ram, on which the accumulator pressure is constantly maintained, is utilised for holding the bottom cupping die in its place. As thus applied, the machine does not, of course, work as a plate-closer; but this is not considered necessary for such light work. Although the arrangement saves expense, inasmuch as one machine is used for the two classes of work, Mr. Tweddell prefers the system adopted, among others by the Wallsend Company, of having a second or lighter machine for furnace mouths. This application is shown in the accompanying illustrations, Fig. 2, but no details of the rivetter are necessary, as it is one of the ordinary kind, fitted with a compound hanger, with the special view of its further use in the construction of the locomotive type of marine boiler. The introduction of these special machines by Mr. Tweddell is enabling marine engineers to meet the demand for large boilers to work at a high steam pressure in connection with triple and quadruple expansion engines. Their design is extremely ingenious, and their construction reflects the greatest credit on Messrs. Fielding and Platt, the manufacturers.

The Grange Iron Company, Durham, exhibit Goodwin and How's patent foundry ladle, which we illustrate by two views given above. This ladle has been designed with the object of dispensing with skimming by hand—which at best is extremely unreliable—and of enabling the metal to be kept hot with the usual covering of sand, &c., while pouring. The body is pear-shaped in plan, the shell being extended on one side to form an external spout, within which is a removable skimmer or dividing plate. This plate projects a little above the top of the shell, and extends down to within a short distance of the bottom, being held in place by screw bolts tapped into the plate and put in from the outside. It is perforated with holes, and has bars for holding the covering of refractory materials. We understand that the ladle is in use in a number of large foundries, and that it has been found to produce a considerable improvement in the soundness of the castings turned out.

The Darlington Steel and Iron Company has an exhibit in the North Court, which consists of a case of templates showing the various sections of steel rolled by the company. These are very numerous; indeed, so varied a class of work is seldom attempted by one firm, and some of the sections are of a character very difficult to roll. Along the front of the case is placed a series of sectional pieces of steel about $1\frac{1}{4}$in. thick, showing the forms taken by the steel bloom in the various passes of the rolls from the ingot to the finished rail. One pair of heavy rolls for rails, the manufacture of the company, is also shown, and one pair of light rolls for steel or iron rounds. A special feature of this exhibit is steel sleepers—of which the company is a large maker—and a great variety can be seen from those used on the main lines of our heavy English railways, and weighing nearly 2 cwt. each, to such as are suitable for the lightest portable railways, and weighing only about 8 lb. each with their fastenings. On two stands, one each side of the case, are rail joints of various descriptions, showing how the ends of two rails are joined together. Pieces of ordinary sections of rails from 10 lb. to 110 lb. per yard are shown, some of them twisted into all sorts of shapes to indicate their quality. Column steel rolled in segments and bolted together, and iron fencing such as is used so extensively in the colonies, complete the exhibit in the main building. In the Model Coal Mine the company shows its steel colliery baulks intended to take the place of timber in coal and ironstone mining. These, we believe, are now coming into very general use in the collieries of the Midland district, and considerable quantities have lately been ordered for use in the Cleveland ironstone mines. When required simply for use between two bearings to support the roof they are applied as an ordinary baulk of timber would be; but if wanted for use as an upright prop the company supply steel caps and shoes which give a level bearing on the top for the cross girder, and also prevent the bottom end from sinking into



GOODWIN AND HOW'S FOUNDRY LADLE.

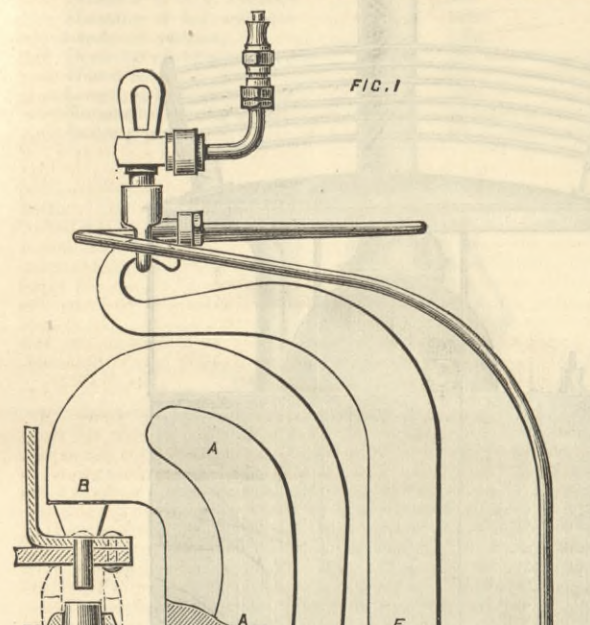
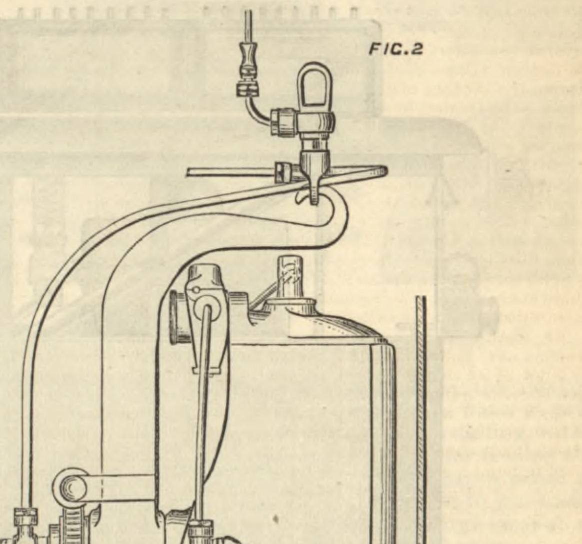


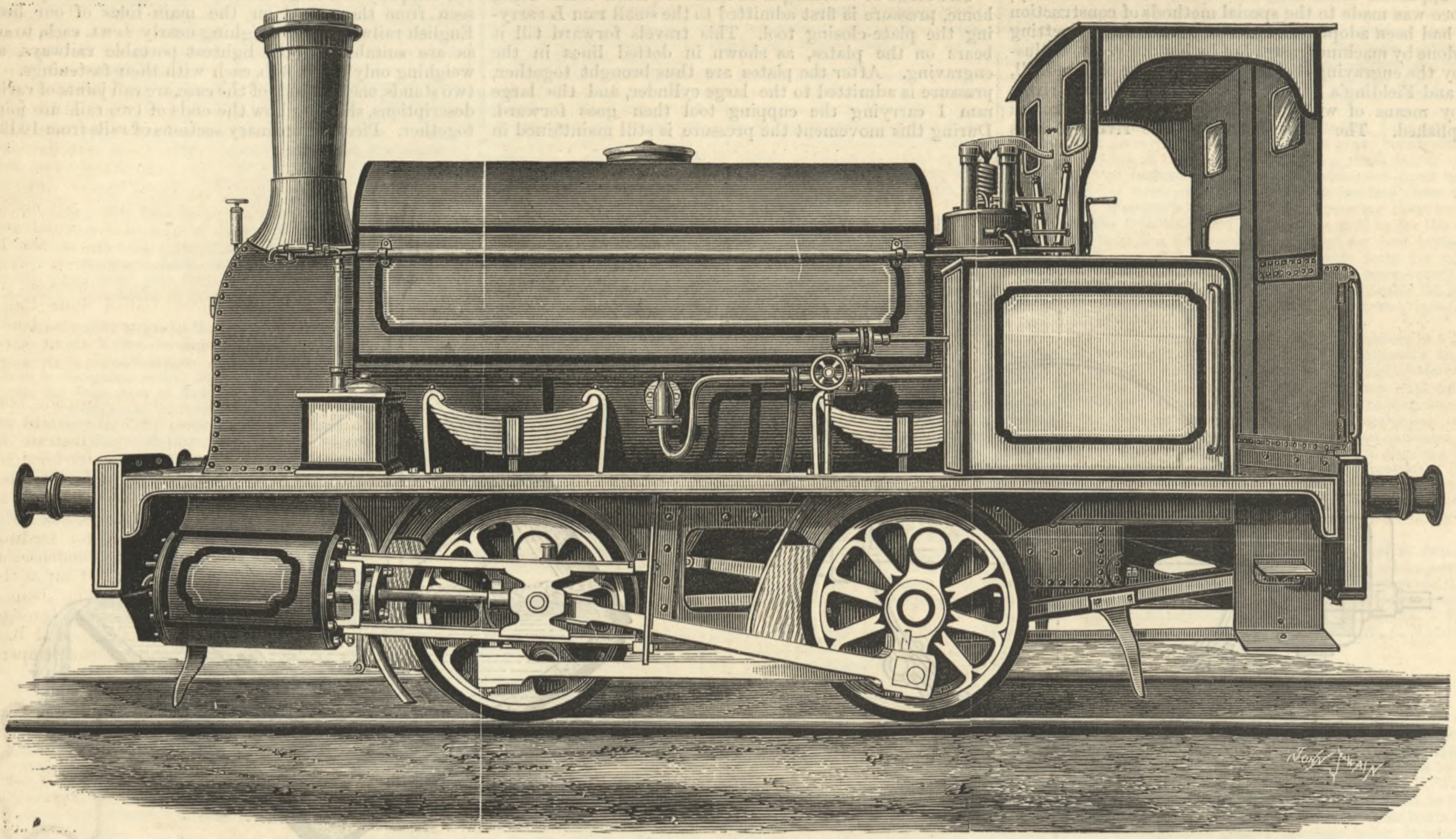
PLATE-CLOSING RIVETTER.

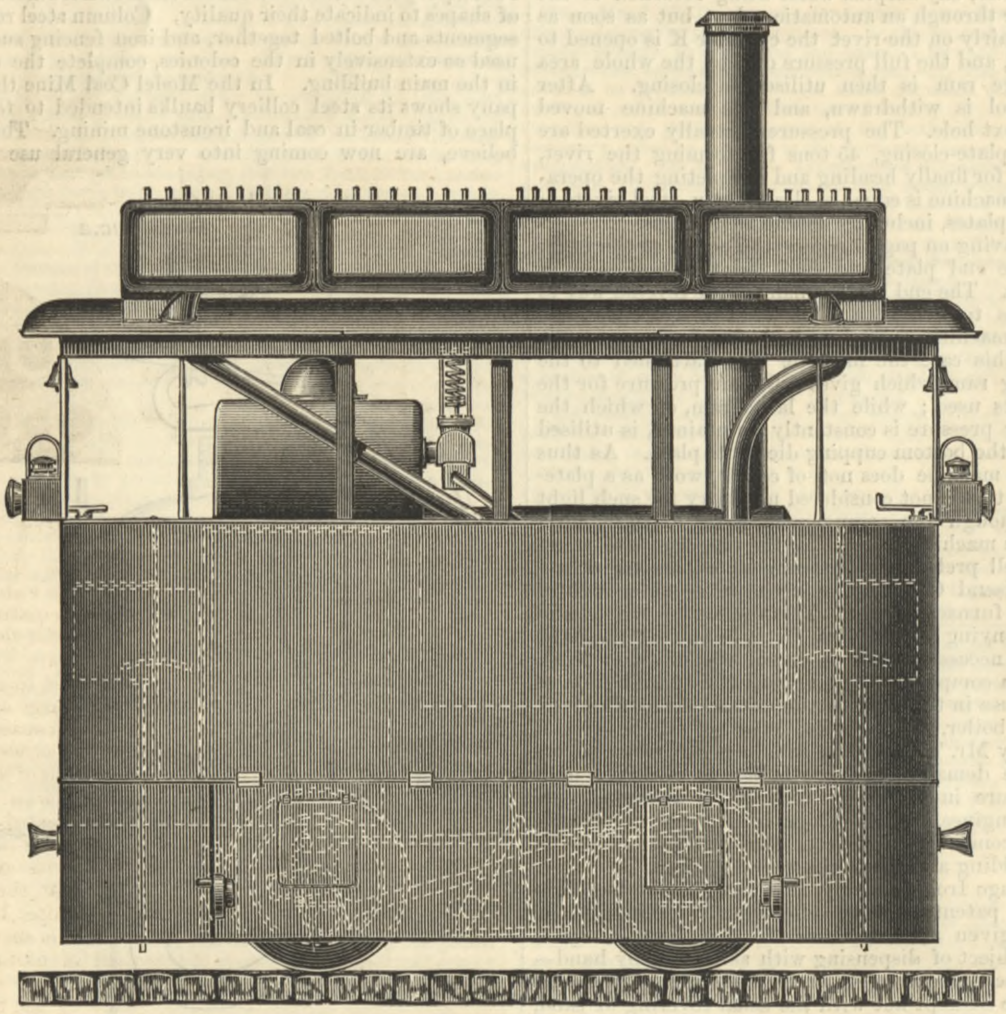


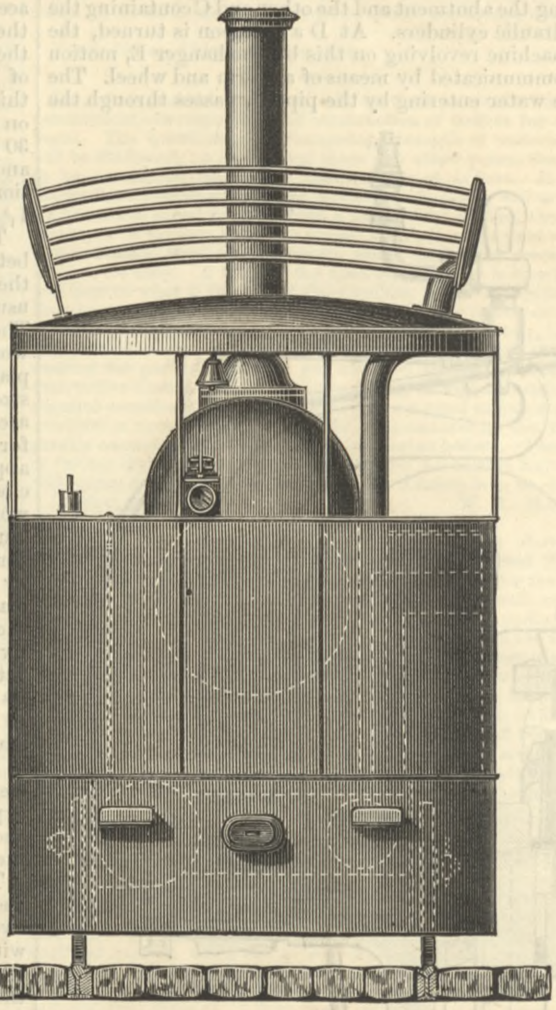
FURNACE MOUTH RIVETTER

LOCOMOTIVES AT THE NEWCASTLE EXHIBITION.

MESSRS. BLACK HAWTHORNE, AND CO., GATESHEAD, ENGINEERS.







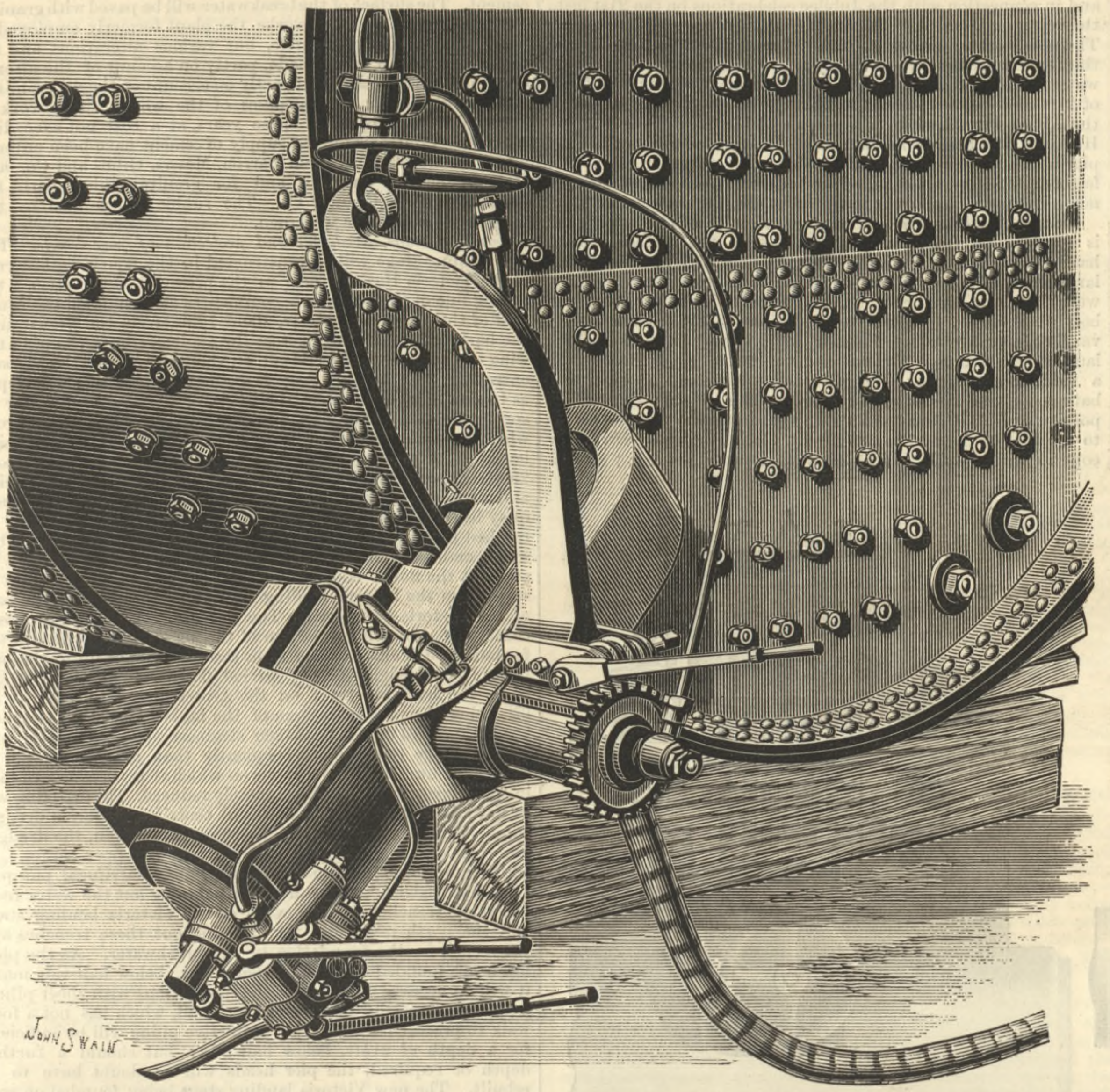
the floor of the mine. This plan is, of course, only adopted in the main ways where the props are intended to stand for a length of time. Where the props are only wanted as a temporary support at the face, caps and shoes are not used. One very decided advantage, besides the permanent nature of these steel baulks for the main ways in mines where the seams are thin, is the additional headroom obtained; a steel baulk 5in. deep taking the place of a 12in. timber baulk, thus giving 7in. more clearance. Where roofs are very broken and uneven the company supplies steel packing for use in the same way as ordinary timber packing.

The small locomotive which we illustrate above has been designed and constructed by Messrs. Black, Hawthorne, and Co., engineers, Gateshead-on-Tyne, for use on light railways in general; also about mines, manufactories, &c. The engine exhibited is intended for working on charging gantries over coke ovens. It is constructed for a gauge of 3ft., and has outside cylinders coupled direct to crank-pins in the wheels, which latter are coupled together. The valve gear is of the ordinary type, worked off the driving axle. The tank is of the saddle form, and the fuel is carried in side boxes. The following are the principal sizes of the engine:—

Diameter of cylinders	6in.
Stroke of pistons...	10in.
Diameter of wheels	2ft.
Wheel base	3ft. 6in.
Total heating surface of boiler	102 sq. ft.
Capacity of tank...	100 gallons
Weight in working order	5½ tons
Boiler pressure	140 lb. per sq. in.

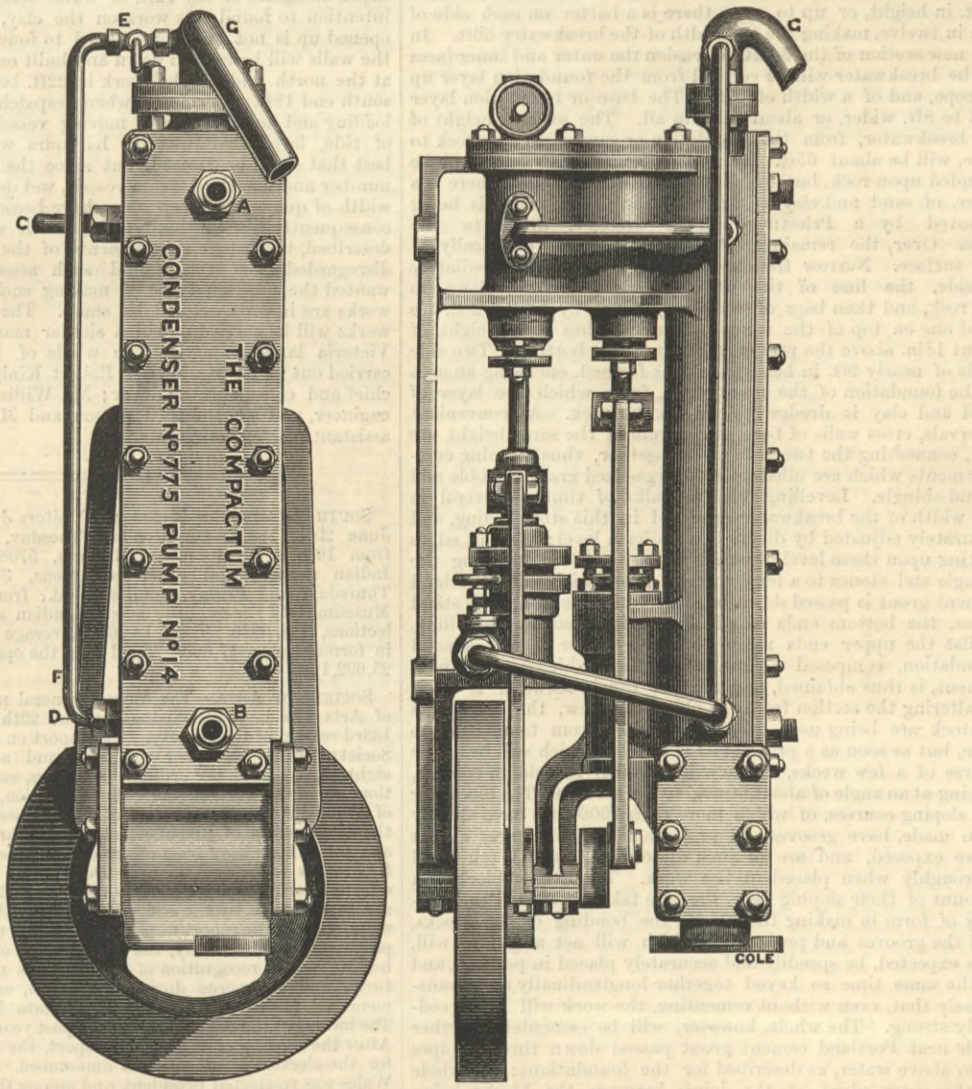
The fire-box is of copper, the tubes of brass, and the boiler shell, tires, crank-pins, motion-bars, piston-rods, &c., of steel. The axle-box bushes, connecting and coupling rod bearings, and cylinder glands, &c., are of gun-metal. All working parts are of the best Yorkshire iron, well case-hardened. Though this engine is so diminutive, it is complete in every requisite necessary for a larger engine, and is well finished off. We also illustrate a compound condensing tramway engine, by the same firm. This engine is built for the 4ft. 8½in. gauge, and has the cylinders placed between the frames and connected direct to the crank axle, the wheels being coupled together by outside rods. The boiler is of the locomotive type, with raised fire-box case and dome on top, from which the steam is taken. The valve gear is of Allan's straight link form. The water tank is placed between the frames at the fire-box end of engine, and has the top shaped to correspond with the ash-pan, which allows the latter to be easily accessible. The condenser is on the roof of the cab, and is constructed in four sections, the exhaust steam traversing each, any steam not condensed finding its way into the hot gases of the smoke-box, where it becomes superheated and passes out of the chimney invisibly. The hot water from the condenser is led into a cistern placed on the foot-plate, and is pumped back into the boiler. The pump is arranged to draw from the cold-water tank or hot-water cistern, or from both together at

THE WALLSEND SLIPWAY COMPANY'S MARINE BOILER.



pleasure. The following are the principal dimensions of the engine:—

Diameter of H.P. cylinder	8in.
Diameter of L.P. cylinder	14in.
Stroke of pistons...	12in.
Diameter of wheels on tread	2ft. 4in.
Wheel base	5ft.
Length over fender plates...	12ft.
Weight in working order	10 tons
Boiler pressure	160 lb. per sq. in.

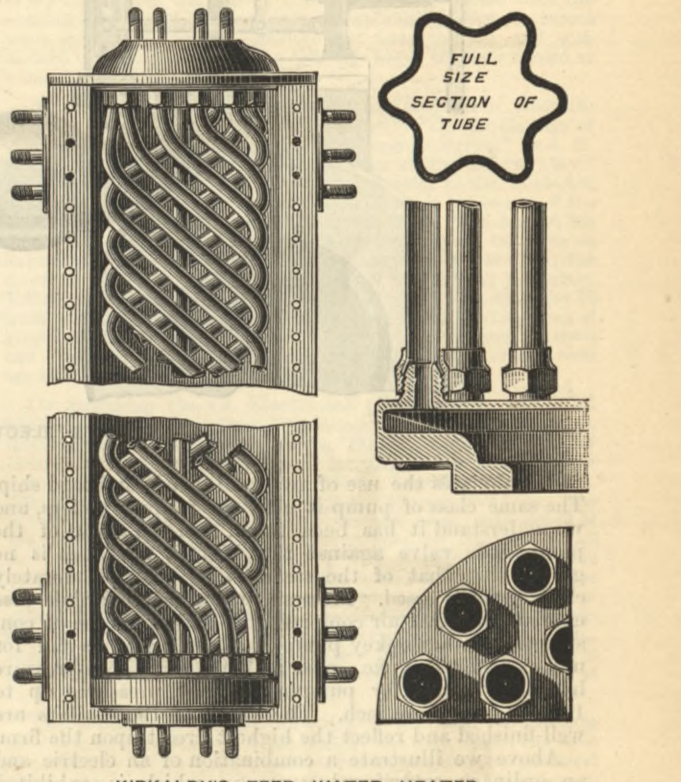


KIRKALDY'S COMBINED "COMPACTUM" DISTILLER AND PUMP.

The engine, although arranged on the compound system, can be worked as a simple engine. This is considered to be absolutely necessary when steep gradients have to be overcome, as well as for facility in starting. Great power is therefore combined with economy in working, as on moderately steep gradients, say, 1 in 19, the engine can work entirely compound, thus getting full advantage of the expansion and the steam. The engine exhibited was in regular work on the Gateshead and District Tramways, where it ran over 1600 miles. Its load frequently consisted of a large double bogie car weighing with passengers over 9 tons. The gradients on this tramway are long and, in some cases, as steep as 1 in 15, with curves of short radius. We believe the results of its trial in actual work were very satisfactory as regards consumption of fuel, power, and handiness. The engine is constructed of the best materials, with fire-box of copper, tubes of brass, boiler shell, frame plates, wheels, axles, tires, crank pins, motion bars, piston-rods, &c., of steel; bushes for axle-boxes, connecting and coupling rods, and cylinder glands of gun-metal; condenser tubes of copper, and chests of brass, and the working parts of best Yorkshire iron well case-hardened. The engine is worked from either end, and is fitted with a governor to regulate the speed, speed indicator, steam and hand brake acting upon all the wheels, most improved type of injector, &c. The car brake can be worked from the engine by steam simultaneously with that on the engine.

In the North Court Messrs. Taylor Brothers and Co., Clarence Ironworks, Leeds, show some excellent specimens of best Yorkshire iron and cast steel. The exhibit includes three locomotive crank axles, two of which—one of best Yorkshire iron and one of cast steel—are machined and finished "bright;" while the third is a round webbed crank axle forging, a new design for one of Mr. T. W. Worsdell's engines. There are also numerous specimens of cast steel work, plates, flanged and otherwise, and a best Yorkshire iron axle to the Indian State Railways pattern, and tested to their requirements, viz., bent cold over a 5in. bar until the ends meet, without showing signs of fracture, and the journals bent to an angle of 45 deg.

Mr. John Kirkaldy, West India Dock-road, London, exhibits a number of his specialities. The patent combination pump and distiller, which we illustrate below has been designed for supplying fresh water for drinking purposes on board ship. It is entirely self-contained, the steam cylinder and pumps being formed in one casting with the condenser. There are two pumps, one for circulating the cooling water and the other for feeding the boiler. The circulating water enters the condenser at the bottom, passes up outside of the tubes and out at the top into a tank for supplying closets, &c. The steam to be condensed travels in the reverse direction, entering by the pipe A, the condensed water flowing out at B, being cooled to within about 10 per cent. of the temperature

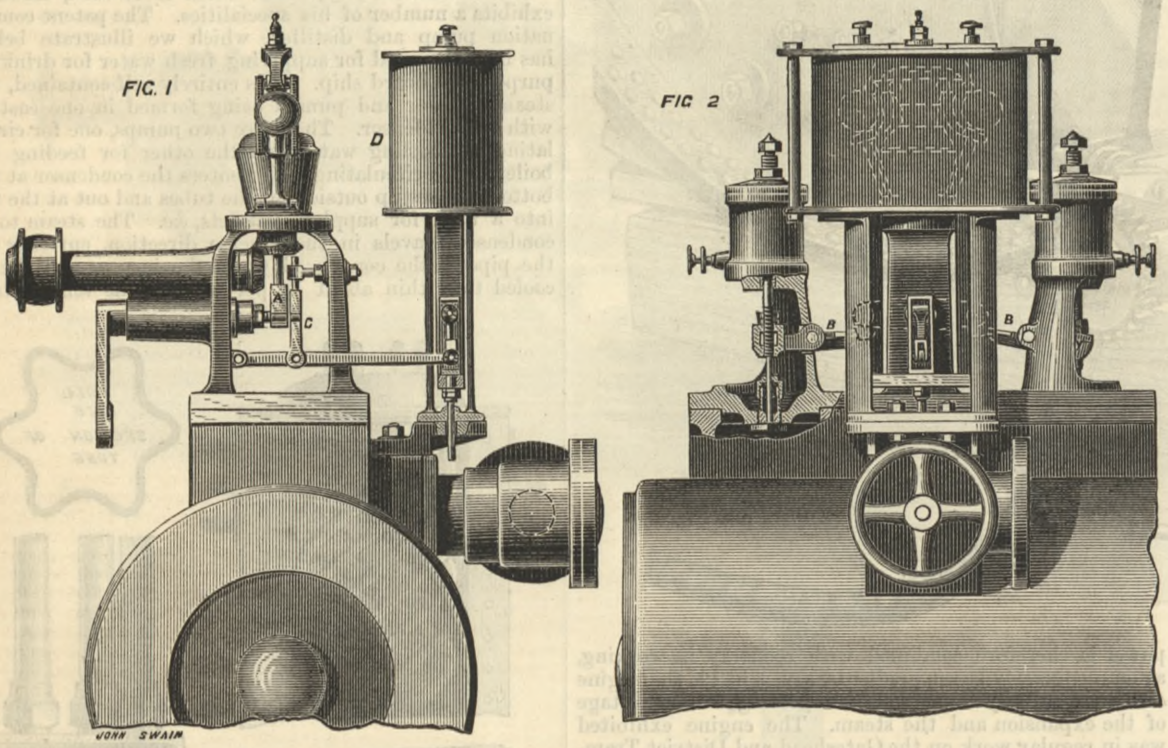


KIRKALDY'S FEED WATER HEATER.

of the cooling water. The steam from the donkey cylinder is condensed in a separate coil, the water so produced, together with some of the heated circulating water, being drawn into the feed pump and used for feeding the boiler. In the interior of the condenser are a series of corrugated copper tubes in spiral coils, fixed to gun-metal tube plates, by means of which a very large amount of cooling surface is obtained in a very small space.

The "Compactum" feed-water heater, which we also illustrate, is used for heating feed-water by means of live steam. It consists of a lagged casing containing spirals of corrugated copper tubes. The water to be heated enters at the bottom, and passes up outside the tubes to the top, branches being provided in either side for its exit. Live steam from the boiler enters the tubes at the top and passes out at the bottom to the hot well, after being condensed. The arrangement of the tubes is shown in the cut, also their section, and the method of fixing them to the tube plates. The latter seems to be extremely efficient. The connection being made by the tube itself on a cone formed on the plate, must ensure a good and permanently tight joint, and must be immensely superior to any method involving either brazing or ferruling. Only solid drawn tubes are employed. Owing to their construction these heaters are peculiarly adapted for working with high steam pressures, and 160 lb. per square inch, or even more, can be used direct, without the intervention of a reducing valve, so obtaining the greatest heating power of the steam. In addition to the foregoing, Mr. Kirkaldy shows a good assortment of his distillers, but as these have been previously described in THE ENGINEER, it is only necessary for us to refer to them at the present time. All Mr. Kirkaldy's exhibits show evidence of careful consideration in their design, and their workmanship is all that could be desired.

Messrs. Carrick and Wardale, of the Redheugh Engine Works, Gateshead-on-Tyne, exhibit a capital collection of their improved steam donkey slide valve pumps, ranging from their smallest size with steam cylinder 6in. diameter by 6in. stroke, and pumps 3in. diameter, capable of pumping 1500 gallons per hour, to one of their largest, having a steam cylinder 12in. diameter and 12in. stroke, and pump 10in. diameter, capable of pumping 23,000 gallons per hour. They are of a very compact, handy and neat design, and appear suitable for every purpose to which pumps of this description can be put. The pump barrels are fitted with D slide valves worked from the crank shaft, for admitting and discharging the water—the suction being on the inner side and the pressure on the back. The valves are therefore not so liable to be choked or clogged by the obstructions often found in ballast water tanks, as pumps with the ordinary form of valve. The pump barrel, plunger, glands and crank bearings are of gun-metal, as also is the slide valve and the loose valve face with which they are fitted. This loose face enables them, in cases of exceptional wear by gritty water, to be readily repaired. The piston-rod is directly connected to the pump plunger, the steam cylinder and pump piston-rods being coupled with a steel crosshead and link in one piece. Every part is easy of access—a great desideratum in pumps for use at sea—the crank shaft and fly-wheel, the piston and plunger rods, and the steam and water valves can each be taken out separately without interfering with any other part. The columns are utilised as air vessels. Either suction and delivery, one or both, can be obtained from the front or from the back, which obviates the use of awkward bends on board ship. The same class of pump is used for feeding boilers, and we understand it has been found that the wear of the pump slide valve against the highest pressures is no greater than that of the steam slide, when moderately clean water is used. Messrs Carrick and Wardale also exhibit a vertical air compressor of the same type of construction as the donkey pumps, for forcing acids and for use in distilleries, &c., also a horizontal high-pressure hydraulic pump for pumping against pressures up to 1000 lb. per square inch. The whole of the exhibits are well-finished and reflect the highest credit upon the firm.



ROBEY'S ELECTRICAL GOVERNOR.

Above we illustrate a combination of an electric and an ordinary centrifugal governor, which is exhibited by Messrs. Robey and Co., Lincoln, in connection with the Proell expansion gear on one of their horizontal engines. The point of cut-off is regulated by the rising and falling of the horizontal spindle A, upon the side projections of which—shown in dotted lines in Fig. 2—rest the horizontal arms of two bell-crank levers, whose vertical arms alternately depress the valve levers B B. As the horizontal arms of these levers are raised the vertical arms come nearer together, and thus release the steam admission valve at an early point in the stroke of the piston, the period of opening remaining unaltered. The horizontal arms of the levers also rest upon two projections in the vertical spindle C, which has a vertical movement imparted to it by the solenoids D, whose position are determined by the intensity of the E M F. By means of a simple resistance box which determines the amount of current which passes, this can be fixed at from 80 volts to 130 volts, and once adjusted to a definite E M F, the solenoids will control the engine at that force only, no matter what variation may be made in the number of lamps in operation. This is what is required for constant illumination. For varying the light— as, for instance, in a theatre—the resistance box may be placed under the control of the stage manager, who without communicating either with the engine driver or the electricians, can raise or lower the whole of the lights at will, and turn off or on any number required. The ordinary governor in this engine does not come into action except when no current is passing round the solenoids. Should, however, a wire get broken or disconnected, then the speed governor will control the working as soon as the speed of the engine increases 2 per cent.

FLOATING DOCK FOR CARDIFF.—The off-shore floating dock built by Messrs. Clark and Standfield for the Dumfries Dry Dock Shipbuilding and Engineering Company, of Cardiff, left the builders' basin at Grays, near Tilbury, on the 24th inst., in charge of two of Messrs. Watkins' powerful tugs. The dock arrived at Cardiff about 8 p.m. on the 28th, having covered the distance of about 550 miles at an average of about five and a half miles per hour.

ST. HELIER HARBOUR.

THE Jersey people have inaugurated with great ceremony, and in connection with the Jubilee celebrations on the 21st inst., the recommencement of the St. Helier Harbour and pier works. The new works now being executed comprise the extension of the Hermitage Breakwater for 500ft., the construction of a deep-water landing-stage at the Victoria Pier, the dredging, to a depth of 21ft. 6in. below the level of half-tide mark cut on the face of the Albert Pier Head, over a portion of the area of the Victoria Harbour, and also over a portion of the channelway outside the pier heads, the protection of the bases of the pier heads and harbour walls by sheet piling, and the continuation of the new north quay wall up to the entrance to the old harbour.

Hermitage Breakwater.—The present length of the breakwater is founded on rock, the irregularities in the surface thereof having been levelled up with bags of concrete. On these bags large blocks of concrete, varying from 60 tons to 80 tons in weight, were laid one on the other, but were neither cemented nor bonded together. On the tops of these blocks smaller blocks, varying from 8 tons to 12 tons in weight, were bedded in Portland cement compo. The outer or exposed blocks are faced with a thick rendering or skin of Portland cement mortar, and battered at the rate of one in twelve. The width of the vertical portion or base of the breakwater, viz., from the foundation up to the tops of the 60-ton and 80-ton blocks, or from 50ft. below cope to within 34ft. of the same, is about 44ft. 4in.; at this level there is an offset or ledge on each side of the breakwater of about 1ft. 4in. in width. The bottom width of the battered portion of the works is about 41ft. 8in., and from this level for 34ft. in height, or up to cope, there is a batter on each side of one in twelve, making the top width of the breakwater 36ft. In the new section of the 500ft. extension the outer and inner faces of the breakwater will be vertical from the foundation layer up to cope, and of a width of 42ft. The base or foundation layer will be 8ft. wider, or about 50ft. in all. The average height of the breakwater, from the foundation or surface of the rock to cope, will be about 65ft. The whole of the extension will be founded upon rock, but over the first 200ft. in length there is a layer, of sand and clay, of nearly 8ft. in depth, which is being removed by a Priestman dipper dredger, down to the rock. Over the remaining 300ft. the rock is practically at the surface. Narrow trenches, parallel with, but immediately outside, the line of the work, are first dredged down to the rock, and then bags of concrete, 7ft. 6in. by 4ft. by 2ft., are piled one on top of the other in the trenches to a height of about 18in. above the present surface of the bottom. Two side walls of nearly 9ft. in height are thus formed, enclosing an area of the foundation of the breakwater, from which the layer of sand and clay is dredged down to the rock. At convenient intervals, cross walls of bags of concrete of the same height are laid, connecting the two side walls together, thus forming compartments which are filled up with large-sized granite rubble and round shingle. Levelling rules or balks of timber—several in the width of the breakwater—are laid in this stone filling, and accurately adjusted by divers to a uniform level; straight edges resting upon these levelling rules being used for sweeping the shingle and stones to a level surface, after which thick Portland cement grout is passed down into the entire mass through stand pipes, the bottom ends of which are inserted in the filling, whilst the upper ends reach to above water level. A solid foundation, composed of granite blocks, shingle, and neat cement, is thus obtained, and on this the breakwater is built. In altering the section from the old to the new, the old blocks in stock are being used, grouted together from foundation to cope, but as soon as a proper bed is formed, which will be in the course of a few weeks, the new blocks will be laid in courses, sloping at an angle of about 60 deg. to the horizon. The blocks for the sloping courses, of which more than 1000 tons have already been made, have grooves and projections on all surfaces except those exposed, and are of such dimensions as to break bond thoroughly when placed in the work. These new blocks, on account of their sloping beds, the care taken in regard to accuracy of form in making the blocks, the bonding of the blocks, and the grooves and projections which will act as guides, will, it is expected, be speedily and accurately placed in position, and at the same time so keyed together longitudinally and transversely that, even without cementing, the work will be exceedingly strong. The whole, however, will be cemented together with neat Portland cement grout passed down through pipes from above water, as described for the foundations; the whole of the outer edges of the joints between the blocks being caulked before grouting to prevent the escape of the grout. This system of grouting has been adopted for cementing together the old blocks which are being used for the extension, and has proved very successful. The blocks are formed of granite rubble built with 5 to 1 Portland cement mortar, the outer or facing blocks having a facing of granite ashlar set in 3 to 1 mortar, the joints between the ashlar for 1in. in depth being raked out as soon as the moulds are removed and pointed with neat cement. The surface of the breakwater will be paved with granite. For the execution of the works the plant formerly employed is being used as far as possible, but various alterations and re-arrangements are being made, partly on account of the altered system of construction, and partly on account of the very limited space available for the purposes of the works. The work is expected to be finished in three years, at a cost not exceeding £50,000. Contracts for the supply of cement have been entered into with Messrs. Burge and Barron, Messrs. Gibbs and Co., and Messrs. Johnson and Co., and for granite ashlar, with the Channel Islands Granite Co. The rubble is quarried by the Harbour Committee's workmen.

Landing stage, dredging and protection of pier heads.—The new landing stage will be constructed in the south-west corner of the Victoria Harbour near to the present landing stage; the coping line of the new work commences at a point on the south wall of the Victoria Harbour, about 100ft. from the west wall of the harbour, and extends across the angle of the harbour to the wing of the Victoria Pier Head, on the inner side of the harbour entrance. The landing stage is being founded at such a depth as to give 30ft. of water at half-tide, or 50ft. at high water of spring tides, the foundations being carried down to the rock which is found at depths varying from 50ft. to 55ft. below coping level. The total length of the works at coping level is about 290ft. There will be two lower landings, the bottom one being at half-tide level and the intermediate one equidistant between quay level and half-tide landing. The lower landings will be reached from quay level by inclined roadways, situated at the south end, suitable for vehicles and foot passengers, and also by stairs at the north end, communicating further with a flight of steps from the bottom landing to the pathway round the base of the Victoria Pier Head. The dredging at present proposed consists of deepening a portion of the Victoria Harbour and the formation of a channel way from the small roads up to the harbour. The dredging will be carried down to a depth of 21½ft. below the half-tide mark on the Albert Pier head, or to about 6ft. below the present bottom of the harbour between the pier-heads, and will enable passenger steamers to come into the new landing stage much more frequently than at present, and of course the number of occasions on which it is necessary to land in small boats will be proportionately reduced. The dredging will be executed by means of a powerful centrifugal suction dredger supplied by Messrs. J. and H. Gwynne, of London, the dredged materials being deposited at sea by means of hopper barges. In addition to dredging the channelway, the centrifugal pump or "suction dredger" will be used for pumping out the water from the piled trenches for the walls of the Victoria landing stage and the north quay, and for dredging out these trenches and the trench for the foundation of the breakwater. As the pier-heads are founded on sand at about 20ft. below half-tide mark, it will be necessary to protect the foundations with sheet-piling, and more especially the Albert Pier head, which has not a foot-walk to protect its toe. This protective piling will be sufficient for a depth of 21½ft. below half-tide; but should a further depth be required, the pier heads will no doubt have to be rebuilt. The new Victoria landing stage being founded on rock at a level of about 12ft. below the foundation of the Albert Pier, no underpinning of the foundation will be necessary when any further deepening of harbour is required.

North quay.—The widening of the north quay to about 180ft. will provide additional berths and quay room. A length of about 900ft. has been already executed, and the remaining length of about 500ft. will be so constructed as to form one side of a graving dock, or a second entrance to a wet dock, if ever such works are constructed, or at all events the new wall will be utilised as a landing quay for either goods or passengers, with a depth alongside of say 12ft. of water below half-tide. It is the intention to found this work on the clay, but if the clay when opened up is not sufficiently hard to found upon, the whole of the walls will be carried down and built on the solid rock, which at the north end of the work is 22ft. below half-tide, and at south end 18ft. Formerly, when despatch was not so urgent in loading and unloading and moving vessels about at all times of tide, large shallow-water harbours were regarded as the best that could be devised, but since the great increase in the number and length of steam vessels, wet docks, great lengths and width of quays, and deep water have become indispensable, and consequently in continuing the north quay in the manner described, the future requirements of the port have not been disregarded, for even should such accommodation never be wanted the additional cost of making such provision while the works are in progress will be small. The foundations of these works will be carried out in a similar manner to those of the Victoria landing-stage. The whole of the works are being carried out under Mr. Walter Robert Kinipple, M. Inst. C.E., as chief and consulting engineer; Mr. William Jaffrey as resident engineer, and Mr. Robert Paterson and Mr. John MacCunn as assistant resident engineers.

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending June 25th, 1887:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m.: Museum, 5708; mercantile marine, Indian section, and other collections, 3324. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 6 p.m.: Museum, 1496; mercantile marine, Indian section, and other collections, free, 3035. Total, 13,563. Average of corresponding week in former years, 17,363. Total from the opening of the Museum, 25,692,122.

SOCIETY OF ARTS.—The annual general meeting of the Society of Arts was held on Wednesday, the 29th inst., concluding the 133rd session of the Society. The report on the proceedings of the Society during the year was read and adopted. There were eighteen papers at the ordinary meetings, seven in the Indian Section, six in the Foreign and Colonial Section, and six in the Section of Applied Art. Five courses of Cantor Lectures were given, and the usual course of juvenile lectures at Christmas. Prizes to the amount of £368 have been offerred for competition to art workmen, for articles to be sent in next December. Prizes have also been offerred for motors for electric lighting. Entries for these prizes are to be made by the end of the year. Amongst other matters mentioned in the report were the reports on the Colonial Exhibition prepared by the Society, the presentation of the Albert Medal to her Majesty in recognition of the progress made in arts, manufactures, and commerce during her reign, and the erection of a memorial tablet on the house of the late Mr. W. M. Thackeray. The income of the Society during the past year amounted to £12,575. After the reading of the annual report, the result of the balloting for the election of officers was announced. H.R.H. the Prince of Wales was re-elected president, and among the vice-presidents were included H.R.H. the Duke of Edinburgh, H.R.H. Prince Albert Victor, Sir Frederick Abel, the Duke of Abercorn, the Attorney-General, Sir Edward Birkbeck, Sir Frederick Bramwell, Sir Philip Cunliffe-Owen, Sir Douglas Galton, the Duke of Manchester, Sir Henry Ponsonby, and Lord Thurlow. Mr. H. Trueman Wood was re-elected secretary.

RAILWAY MATTERS.

THE first street railway in America was completed in New York city in 1832.

THE Governors of Eastern Siberia and the Amoor district have received an Imperial order to refer to the Minister of Communications in all matters concerning the new Siberian-Pacific connecting lines of railway, instead of the Minister for War, as at first decided; so that the control of the construction is thus taken out of the hands of Generals Vannofsky and Annenkoff.

ON the 22nd inst., as a heavy train was descending the incline at Peatsferry, on the railway between the Hawkesbury River and Sydney, the brakes failed to act, and the train dashed into a siding. Coming into contact with fearful force with the obstruction at the end of the siding, the train was almost completely wrecked. The engine-driver and six others were killed, and forty of the passengers were injured, some seriously.

AT present there are only 332 miles open to traffic in Japan, but 357 miles are in course of construction, and 145 miles, projected, have entered a practical stage. There are different styles of roads, some being on the American and German principles, but the majority are on the English system. The engines, with the exception of a few American, are all English, in addition to the wheels and axles of carriages. A great deal of the woodwork is being constructed in Japan.

A PORTION of the Cologne express, which left Berlin at half-past nine on Sunday night, and was due at Cologne shortly before eight on Monday morning, left the rails at Mülheim on the Rhine, the station before Deutz. No lives were lost, but seventeen persons were injured, one lady receiving a bad wound on the head. Two of the passenger carriages were overturned and dragged some distance by the engine, but fortunately the sleeping car was not thrown off. This derailment is probably due to buckling of the rails through expansion by heat.

A RAILWAY project is on foot which may probably have a stimulating effect on the Chinese Empire. Russia, it is announced, has resolved to push forward its railway communication through Siberia to the Pacific Ocean. The calculation is that the work may be completed within five years. There will be direct communication between St. Petersburg and the Pacific ports in fifteen days. The route lies from St. Petersburg to Tiumen, five days; thence to Tomsk, three days; thence to Stretinsk, two days; thence to Khanka Lake by the Amoor, four days; and from Khanka to Vladivostock, one day. Russia will thus be an uncomfortably, always-on-hand sort of a neighbour.

THE East Indian Railway Company's report shows that on 1515 miles of line the railway earned in the second half of last year £1,970,406, or £6320 less than in the corresponding period of the previous year. The coaching traffic for the half year represents 480,047,800 passengers of all classes carried one mile, and for the whole year 982,465,927, at an average charge of ·310d. and ·310d. respectively, as contrasted with 441,542,567 and 937,904,921 passengers at an average charge of ·312d. and 310d. in the corresponding periods of 1885. The goods traffic for the half year represents 477,720,535 tons carried one mile, and for the whole year 1,051,092,178 tons, at an average charge of ·659d. and ·666d. respectively, as against 487,104,205 tons and 1,040,181,334 tons, at an average charge of ·672d. and ·681d. in the corresponding periods of 1885.

AN analysis of the capital expenditure of the last five years by the North British Railway Co., shows that the outlay on works of improvement have been at the rate of a little over £100,000 a year. New lines have taken £753,000, of which £591,000 has been upon the new Tay Viaduct and its connections. In the last five years £114,000 has been charged to capital for new engines. The number has at the same time been increased by 58, so that each new engine of the modern type which has been put upon the road represents an average cost, as charged to capital, of less than £2000. For passenger vehicles £82,000 has been charged to capital. For this about 200 vehicles additional have been added, while many others have been enlarged and improved up to the modern requirements. A sum of £208,000 has been charged for wagons and wagon equipment; for this about 3200 additional vehicles have been acquired, equivalent to an average cost of less than £70 per vehicle. There has also been a very large expenditure upon the "block" system, upon new docks and piers, and by way of subscriptions to other railways.

WRITING on cable tramways, in the *Street Railway Journal*, Mr. D. J. Miller, of the Tenth Avenue Cable tramway, New York, gives in a short space a history of the development of the various systems of the day. Four years ago there were in the United States 36¼ miles of cable road in operation and under construction. On the 1st of January, 1887, there were 116 miles additional in operation and under construction, making a total of 152¼ miles. It is estimated that during the ensuing year at least 100 miles of cable road will be built in this country. There are seven different States in which roads are in operation. San Francisco leads the list with 33 miles, Chicago comes next with a fraction over 20, and Philadelphia is third with 18 miles in operation. Mr. Miller places the cost of a cable road at 221,100 dols. per mile. This figure covers every item of expense connected with the building and equipment. He gives the operating expenses of 2½ miles of road bed as 132,953 dols. This covers every expense of officers' salary, pay of employés, taxes and interest at 5 per cent. on first cost.

A PERMANENT-WAY engineer writes:—"I have had a very lively time of it with this wave of heat. We have blindly introduced steel fish-bolts, bolts that require a wrench 5ft. long. The consequence is, the bolts have been screwed up too tight, and, in spite of warnings of previous years, I had a case of the steel rails buckling, diverging 9in. from the straight line, and, of course, inclined to go farther. Luckily the train was going slowly. Gangers had been ordered to slacken the bolts, but neglected to do so. I had sent out orders to slacken these steel bolts. On a neighbouring line there were 300 yards of the line impassable by buckling, and near Liverpool the line was impassable from the same cause. There was room between the rail ends, but the bolts prevented the rails from sliding in the fish-plates. It is a bad reflection on engineering talent. Now I have the fish-bolts loosened, I am threatened with a creeping of the line, which will jam up the joints close at the bottom of the hill. Rails are not sufficiently anchored in their places; nothing holds the rails of many lines except the friction at the side of the rail between it and the dry, loosened wood keys."

THE Canadian Pacific Railway Company furnishes the following dates and facts about its route from Japan to England:—"The Abyssinia left Yokohama on May 30th and reached Vancouver on June 13. Her passengers reached Montreal on June 20th. They were detained a day and a-half in New York waiting for the departure of the City of Rome, which is due in Liverpool on Thursday next, June 30th, or less than thirty-two days from Yokohama. A few chests of tea, as evidence of what can be done, are coming by the City of Rome. Were the Canadian Pacific Railway Company's steamers on the Pacific, a day and a-half at least would be saved on that ocean. At least one day can be saved over the time at present allowed for the transcontinental run; and the New Canadian Atlantic service will, it is hoped, work in with the Pacific service, so as to avoid delays. On the whole, we can calculate on making the time between Japan and England less than thirty days for mails, passengers, and light freight. Under the new P. and O. contract, which provides for accelerated speed, the mail time from Japan, *viâ* Brindisi, will be forty-four days. For passengers and freight, *viâ* Gibraltar, the time will be fifty-three days."

NOTES AND MEMORANDA.

AT the paper mills of Messrs. Towgood and Sons, at Sawston, Cambs, one of Hayward Tyler and Co.'s "Universal" steam pumps, 12in. by 8in., has been at work night and day for over twelve years. On a very moderate computation, allowing full margin for possible stoppages, this little pump must have raised over 1,000,000,000 gallons, or 5,000,000 tons of water, and it is still running and doing its work.

IN London last week 2182 births and 1287 deaths were registered. The births were 537, and the deaths 157, below the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes fell to 15·9, a lower rate than has been recorded since the last week of June, 1886. During the first twelve weeks of the current quarter the death-rate averaged 18·1 per 1000 and was 1·8 below the mean rate in the corresponding periods of the ten years 1877-86.

HERR W. BORCHERS describes in *Dingl. Polyt. J.*, 263, 32—34, a new galvanic element. The cell containing the exciting agent consists of an ordinary wrought iron tube closed at one end, and in which a zinc or tin rod is suspended. The iron tube forms the positive pole. The exciting agent is a solution of sodium hydroxide and sodium nitrate, sodium chloride being added to increase the active power of the solution. For technical purposes the ratio of $Na_2O : NaNO_3 : NaCl = 90 : 80 : 300$ may be used.

IN the twelve months ending May 20th, 1887, photographs of the sun have been taken at Greenwich on 215 days, and of these 421 have been selected for preservation, besides 16 photographs with double images of the sun for determination of zero of position. For the year 1886 Greenwich photographs are available on 199 days, and photographs from India and Mauritius filling up the gaps in the series, on 164 days, making a total of 363 days out of 365 on which photographs have been measured, the record being thus practically complete for 1886.

AN electric trumpet has been recently devised by M. Zigang (*La Nature*, June 4th). It consists of a short brass tube mounted on wood and containing an electro-magnet whose ends face a vibrating plate, on which is fixed a small piece of soft iron. Against this plate-armature rests a regulating screw with platinum point, which serves for automatic interruption, by vibration of the armature. With two Leclanché elements a musical sound is had, which may be varied in pitch, intensity, and timbre by means of the screw. This instrument may be usefully employed in signalling on ships, railways, tramways, &c.; it may also serve as a receiver for signals of the Morse type.

ACCORDING to some experiments on the relation of the conductive capacity of gases to their temperature, by A. Winkelmann, in which the conductive capacity is determined by means of three horizontal copper plates immersed in the gas and separated from one another by glass balls, the upper and lower plates being maintained at fixed and different temperatures, the results are:—For air, mean of four experiments, 0·00206; for carbonic anhydride, four experiments, 0·00366; for hydrogen, two experiments, 0·00206. The heat given off by a plate immersed in gas is different according to its orientation, hence that given off by a given area cannot be determined from the rate of cooling of the whole.

A PAPER on heats of combustion was recently read before the Paris Academy of Sciences by MM. Berthelot and Recoura. Continuing their studies of the heats of combustion by the new calorimetric method, the authors have determined the mean for glucose at 3·762 calories; for quinone, 6·102; for naphthalene, 9·688; for benzoic acid, 6·345; and for salicylic acid, 5·326. These studies are being continued with a view to determining the heat of combustion of liquid and volatile bodies, and the measure of the heat of combustion of pure carbon in its various states. Notwithstanding its fundamental importance for calculating the heats of formation of organic compounds, this element has been neglected since the time of Favre and Silbermann.

AT a recent meeting of the Paris Academy of Sciences, a paper was read describing "Researches on the Density of Sulphurous Acid in the state of Liquid and of Saturated Vapour," by MM. L. Cailletet and E. Mathias. Having already described the method employed by them for determining the density of ethylene, of the protoxide of nitrogen, and of carbonic acid as liquids and saturated vapours, the authors here generalise their method by applying it to the study of a substance—sulphurous acid—whose critical point, approaching 156 deg. Cent., is much higher than that of the former gases. Their researches show that the densities of the liquid and of the saturated vapour have a common limit, which is opposed to the conclusion arrived at by Avenarius; also that the critical density is 0·520.

THERE is at present one great drawback to the use of aluminium bronzes for small manufactured articles—the difficulty of soldering. There is now no cheap and simple method of brazing aluminium bronzes, and they cannot be welded. Pieces, however, can be, Mr. E. D. Self writes, united by the following jeweller's solders: Hard solder for ten per cent. bronze, gold, 88·88 per cent.; silver, 4·68 per cent.; copper, 6·44 per cent. A middling solder for 10 per cent. bronze, is gold, 54·40 per cent.; silver, 27·60 per cent.; copper, 18·00 per cent. A soft solder for aluminium bronzes in general is made by adding brass to the ingredients already given, thus: Brass, 14·30 per cent.; gold, 14·30 per cent.; silver, 57·10 per cent.; copper, 14·30 per cent. The brass is composed of copper, 70 per cent., and tin, 30 per cent.

PROFESSOR J. W. MALLET, F.R.S., has analysed the ash collected at Bahia de Caraguez, about 120 miles west from Cotopaxi, where it fell to the depth of several inches. The specimen was a light brownish grey, very finely divided, mobile powder, soft to the touch. Quartz, two felspars, augite, magnetite, and thin scales of deep red specular iron ore were distinguished by aid of the microscope. When strongly heated, it turned dark red-brown, and fused to a nearly black slag. Several concordant experiments proved that silver was present to the extent of about one part in 83,600 of the ash, or about two-fifths of a Troy ounce per ton of 2240 lb. Small as is this proportion, it must represent a very large quantity of silver ejected during the eruption, in view of the vast masses of volcanic ash which must have been spread over such an area as is indicated by the fall at so distant a point as Bahia de Caraguez.

A PAPER on "The Electrical Conductivity of Solid Substances at a High Pressure," by L. Graetz, is given in abstract in the *Journal of the Chemical Society*. Hitherto our knowledge of the conductivity of electrolytes is derived for the most part from results obtained with the substances in the dissolved and not in the fused condition. The only generalisation at present deduced is that solid substances are not conductors at low temperatures, but their conductivity commences at temperatures far below the melting point, and increases with the temperature. If then this increase of conductivity is due to an increase of molecular mobility and of the number of molecular impacts, increase of pressure without alteration of temperature should be effective to a like degree. In the paper, this point is examined by means of a compression apparatus, capable of giving a pressure of upwards of 4000 atmospheres. The results are given for the halogen-compounds of lead and silver, and for sodium nitrate. The substances examined are divisible into two classes, in the one of which, with application of maximum pressure, the resistance rapidly decreases to a constant point, and in the other this minimum resistance is, under the same condition, only attained after several hours. To the former class belong the halogen-compounds of silver, to the latter those of lead and sodium nitrate. In the paper full details are given of the apparatus used, and of the methods of experiments; the results are tabulated.

MISCELLANEA.

MR. THOMAS LUCAS, of Ashtead Park, Surrey, and Kensington Palace-gardens, the senior partner in the firm of Lucas and Co., has received the well-merited honour of a baronetcy.

AMONG the honours conferred by the Queen, on the completion of fifty years of her reign, is a baronetcy bestowed upon Mr. Richard Moon, chairman of the London and North-Western Railway Company.

IN connection with the Hammersmith New Bridge, recently opened, the Brentford Gas Company has laid across it and upon each side of the bridge gas mains of wrought iron 12in. lapwelded drawn screwed tubes in place of the ordinary cast iron pipes. The tubes were made by Mr. Aird, Wellington Tube Works, Staffordshire.

IT is said that water is so scarce at Swansea that it is sold in the streets at 1d. per can. In some districts the inhabitants have had no water for two days. The weather still shows no sign of breaking, and great alarm is felt. It is stated that the water remaining in the reservoirs is not in a satisfactory condition. The water committee are taking steps to utilise the water in a large disused colliery.

THE Redstone Coke Company has just completed the largest reservoir in the Connellsville, U.S., coke regions, which will supply water for their 470 coke ovens and other works in the vicinity. The reservoir covers an area of five acres, and has a capacity of near 14,000,000 gallons. The depth of water will average 7ft. The water is taken from Hutchinson run, through a race 1050ft. in length, and is pure mountain spring water.

M. DAHLL, a mining engineer, who has been examining the north of Norway on behalf of the Norwegian Government, states in his report that all the rivers in the interior of Finnmarken, a district of fifty Norwegian square miles, carry gold. The metal is found in sand contained in little hollows, which by their shape prevent its being washed away by the water. The weight of the gold grains varies from 10 milligrammes to one gramme. Platinum is also found occasionally.

THE German Societies of Engineers are anxious to establish a standard screw thread based on the metrical system, and have been in communication with American engineers with regard to the Seller's thread in use in the United States. Germany favours this standard, partly because the balance of opinion received from America inclines towards the Seller's thread in preference to the Whitworth, and also because, in addition to being in uniformity with the metrical standard, the threads are square at top and bottom, and afford a larger bearing surface than the rounded Whitworth thread. Many experiments have in recent years shown the general superiority of finer threads, and with modern tool making there is no difficulty about the finer thread as a commercial one.

AT the meeting this evening of the Geologists' Association the following papers will be read:—(1) "On the Geology of Cornwall, with special reference to the Long Excursion," by J. H. Collins, F.G.S., and (2) "On the Deposition of the London Clay," by J. Starkie Gardner, F.G.S. The testimonial to Dr. Foulerton will be presented to him by Dr. Hicks, F.R.S., in the course of the evening. The long excursion referred to will be from August 8th to the 13th. An excursion to Sudbury, Suffolk, will be made on Saturday, July 9th, in association with the Essex Field Club; the directors will be Dr. J. S. Holden, of Sudbury, and W. Whitaker, F.R.S., of the Geological Survey. Leave Liverpool-street by 10 train, due at Sudbury 11.45. The finest set of inland sections of glacial drift in the eastern counties occurs close round the town and the most westerly sections of crag. The older tertiary beds are also well shown.

ON Saturday the s.s. Electrician proceeded on her trial trip from Middlesbrough Dock. This vessel is the fifth built by Messrs. Raylton, Dixon, and Co. for Messrs. Thos. and Jas. Harrison, of Liverpool, and is specially adapted for their Calcutta trade. Her leading dimensions are:—Length, 337ft.; breadth, 40ft.; depth, 29ft. 2in.; and she has a carrying capacity of over 4000 tons. She is built entirely of steel to Lloyds' highest class, with Board of Trade certificate for passengers, and is specially complete in all her arrangements for cargo loading and discharging. She has hood aft with deck-house, containing saloon and state-rooms for accommodation of passengers, long bridge amidships, and top-gallant forecastle. Her engines are by Blair and Co., of Stockton, on triple expansion principle, having cylinders 24in., 40in., and 66in., and stroke 45in., and indicate 1500-H.P. The trial trip proved in every respect satisfactory, and she attained a speed of 12 knots.

THE scheme of the Corporation of the City of London to obtain independent water supplies in the City, which has been discussed for a considerable period, has at length taken practical form. Some weeks since the Commissioners of City Sewers invited tenders for sinking an artesian well into the chalk at the Artisans' Dwellings close to Bishopgate-street, E.C. All the most prominent firms in this branch of engineering competed, and at a meeting of the Commissioners, the Streets Committee—who had the matter in hand—reported that the tender of Messrs. Z. Hills and Co., of Abbey Works, Old-street, London, should be accepted. The report was carried, and referred back for execution. The necessary formalities having been completed, the works will forthwith be commenced. It was stated that Lieutenant-Colonel Haywood, the City engineer, had taken great trouble in the matter, and hope was expressed that this well would be the means of relieving the ratepayers of a grievous impost.

A NUMBER of interesting experiments have recently been made with such electrical machines as are employed in industries, with the view of determining under what conditions they may become dangerous. These have been conducted by M. D'Arsonval, who has already established the fact that what is truly dangerous where these machines are used is the extra current that occurs at the moment the current is broken, and in order to annul this extra current he proposed to interpose a series of volta-meters containing acidulated water along the conducting wire. The new arrangement now employed is at once more simple and efficient. It consists of a V-shaped tube made of an insulating substance, which, after being filled with mercury, is interposed in the main current. In order to close the latter, it is only necessary to turn a tap, which is arranged similarly to the tap on a gaspipe. In this way the machine is unprimed without its being able to give an extra current spark. Currents are not dangerous until a power of 500 volts is reached.

THE American *Sanitary Engineer* of New York says:—The Court of Appeals of the State has just rendered an important decision in reference to the powers of a town in the matter of the disposal of its sewage. The city of Rochester discharged its sewage into an open drain which it had constructed across lands situated within the adjoining town of Brighton, and in such wise as to create a nuisance. The town Board of Health thereupon issued an order prohibiting the use of this open drain, but having no power to go within the limits of the city of Rochester and abate the nuisance by preventing the discharge of the sewage, it brought suit in Court against the city for an injunction restraining the discharge of the sewage into the open drain without its own limits and within the boundaries of the adjoining town of Brighton. The Court granted the injunction, and upon ultimate appeal to the Court of Appeals the action of the Court below has been sustained. This seems to be an eminently just decision. One town or city ought not to perfect its own system of sewerage to the detriment of its neighbour.

COMPOUND DIRECT-ACTING PUMPING ENGINES, HAMPTON.

MR. J. W. RESTLER, M. INST. C.E. ENGINEER; MESSRS. MORELAND AND CO. CONSTRUCTORS.

(*For description see page 13.*)

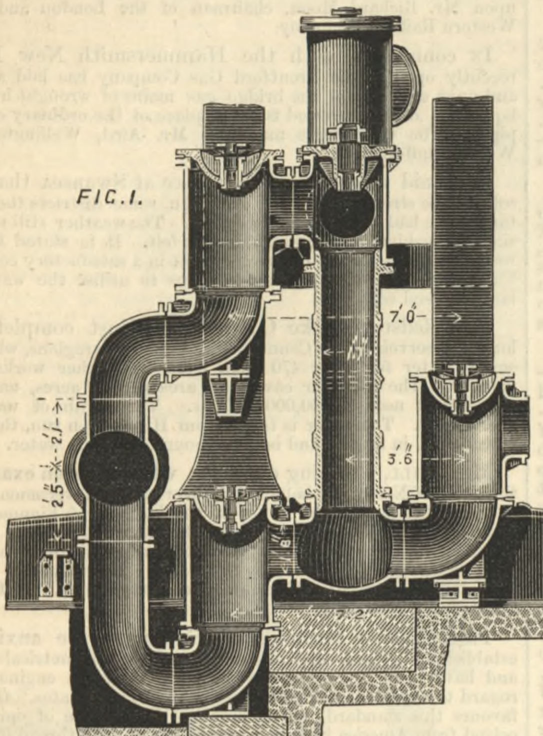


FIG. 1.

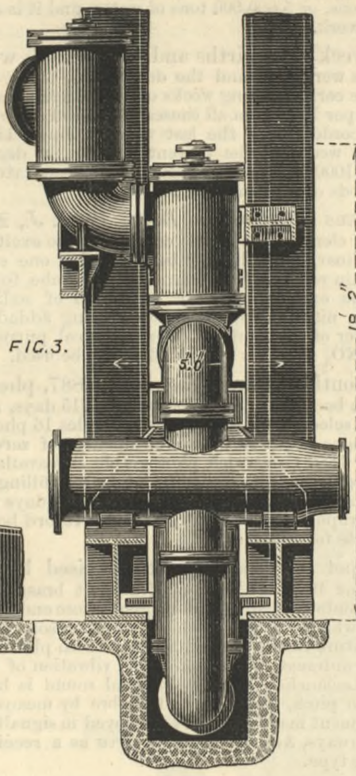
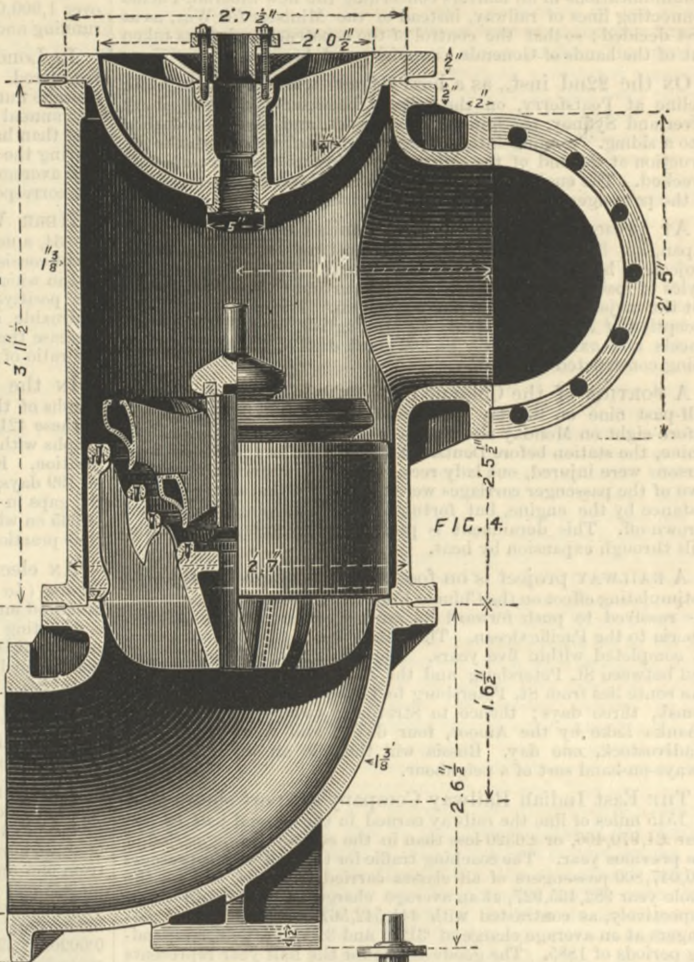


FIG. 3.



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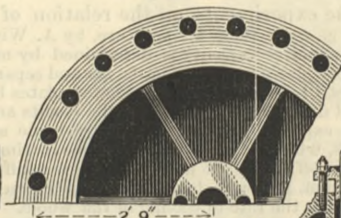

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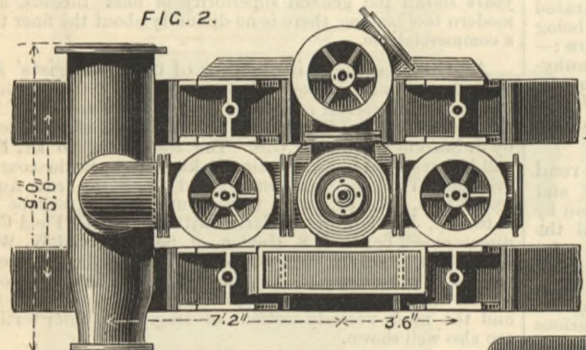

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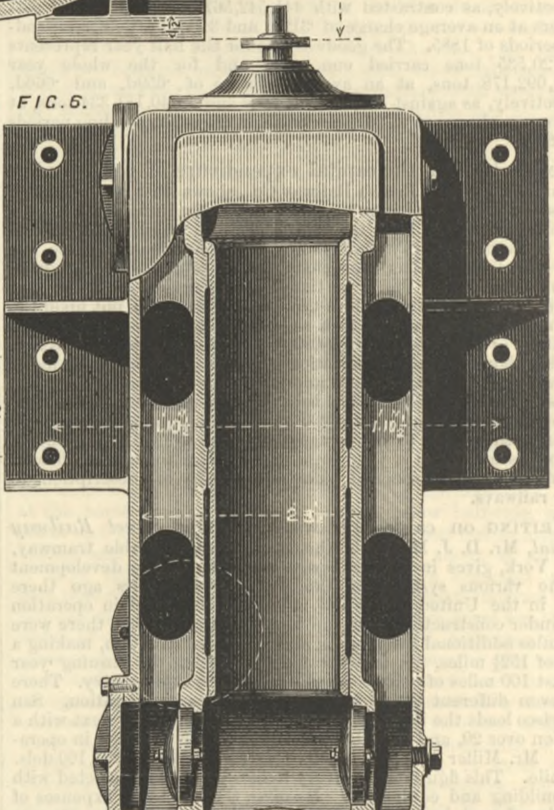

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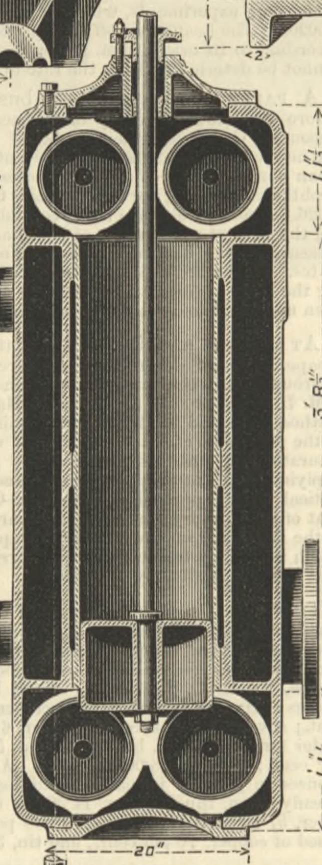

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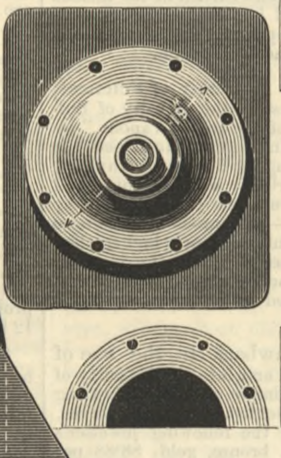

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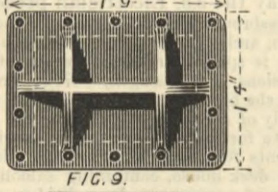

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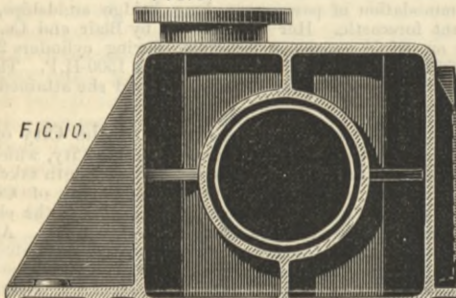

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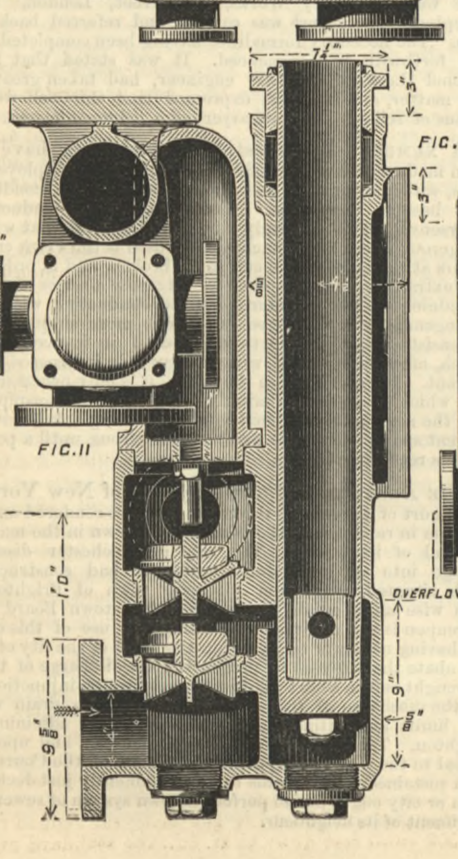
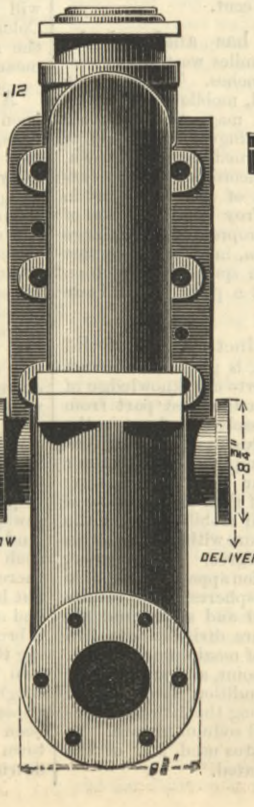


FIG. 11 FIG. 12



DELIVERY

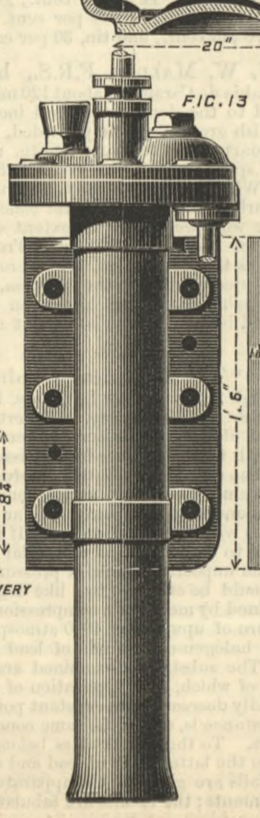


FIG. 13

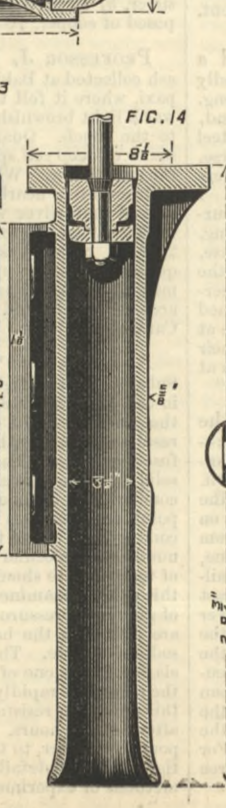


FIG. 14

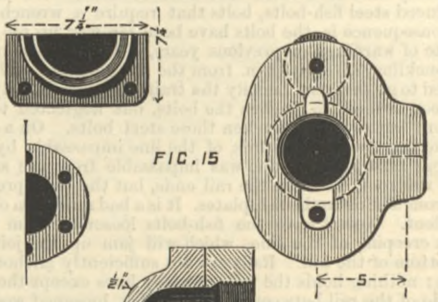


FIG. 15

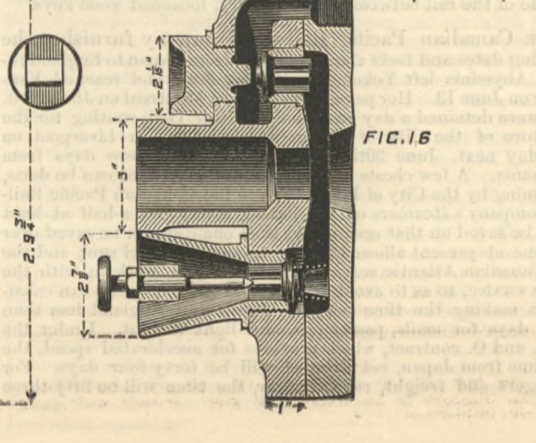


FIG. 16

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NEW YORK.—THE WILLMER and ROGERS NEWS COMPANY, 31, *Beekman-street.*

CONTENTS.

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.*

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

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

W. R (Cathays).—*The engine of which you speak has not been illustrated in* THE ENGINEER.

J. D.—*The tendency would be, and in general the actual result of working would be, that the bolt would gradually permit the sinking of the two parts of the chair into the sleeper at the centre where they meet, and this might take place irregularly. By the time the chair is arranged to prevent this, it will have become more costly, and in any case the greatest difficulty is to get such a chair adopted in preference to those in use, or those pushed by specialists.*

TINNING GUN-METAL.

(To the Editor of The Engineer.)

SIR,—Can any reader tell me the best method for tinning gun-metal so as to resist acids? The acids are those used in the manufacture of soda water. FORTIS.

SAWING GRINDSTONES.

(To the Editor of The Engineer.)

SIR,—Can some of your correspondents inform us if there are any sawing machines made suitable for cutting the refuse stone in quarries into blocks like bricks? R. P. AND S.

HOLYHEAD STEAMERS.

(To the Editor of The Engineer.)

SIR,—I see that the s.s. Ireland crossed from Holyhead to Kingstown with the sons of the Prince of Wales in 2 hours 58 minutes, and this is said to be the fastest trip on record. But if I am not misinformed, the N.W. boat Violet ran from Dublin to Holyhead on her trial trip—four miles further—in three hours. If I am wrong on this point, perhaps some of your readers will correct me. PADDLE.

Chester, June 29th.

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DEATH.

On the 23rd inst, at Sunnyside, by Lanark, suddenly, RONALD JOHNSTONE, C.E., Glasgow, in his sixty-eighth year. Friends will please accept of this intimation.

THE ENGINEER.

JULY 1, 1887.

BLAST PIPES.

IT is a remarkable fact that while all locomotive engineers know that the part played by the blast pipe or exhaust nozzle of a locomotive engine exercises a most important influence on the performance of the engine, little or no effort has been made to improve it. In the old days of coke fires and gab gear, very small blast pipes were used. The back pressure was correspondingly high, but the engines kept steam well, and nothing more was demanded. As further experience was gained, the blast pipe was made larger and larger, and locomotive superintendents boast of the size of their blast pipes as an evidence of the good qualities of their engines. But in Great Britain nothing has been done until quite recently to add to the efficiency of the exhaust. On the Continent at a comparatively early period adjustable blast pipes were used, and are still very freely employed. The area of opening can be altered at will from the foot-plate to suit the demands of the boiler for steam. But in this country adjustable blast pipes have hardly ever been fitted. It is not easy to say why, unless that locomotive superintendents have thought it better to regulate the production of steam by the aid of ashpan dampers. No attention has been paid worth mentioning in this country to the height of the blast pipe. It was held that so long as it stood just above the top row of tubes it was about right, two or three inches more or less making no difference. Almost the only exception we can name was the practice of Mr. David Joy, who, when locomotive superintendent of the Oxford and Worcester Railway in 1856, used blast pipes $5\frac{3}{8}$in. diameter, with cylinders 16in. by 22in. stroke. The driving wheels were 5ft. 9in. diameter. The blast pipe was placed very low down in the smoke box, and had a copper top, the position of which could be adjusted till the best result was got. The engines weighed about 32 tons, and hauled eight coaches weighing about 9 tons each. The run of fifty miles was made in one hour and twenty minutes, with four stops, on 20 lb. of coke per mile. In the United States engineers very early adopted what is known as the "petticoat pipe." That is to say, the true exhaust nozzle was put very low down in the smoke-box, and above it were arranged a series of truncated cones, the small end of one standing in the large end of the next one above it. This scheme works well, reducing the discharge of cinders, and augmenting the power of the boiler. This has never been adopted in England, and only to a limited extent in Europe. Quite recently, however, locomotive superintendents have turned their attention to the blast pipe; Mr. Adams, of the South-Western, Mr. Webb, of Crewe, and Mr. Appleby, of the Waterford and Limerick Railway, all working in the same direction, but on somewhat different lines. Before describing what they are doing, it will be well to explain what is the object they have in view.

In a locomotive boiler, the calorimeter or cross sectional area through the tubes is so large that the products of combustion can select which tubes they will pass through. The result is that all the tubes are not equally efficient. The hot gas not only takes the line of least resistance, but it obeys the greatest pulling force. A little thought will suffice to show that the products of combustion, because of their levity, will always try to rise. They will therefore tend to escape through the upper rows of tubes in preference to the lower rows. Furthermore, in order to get at the lower rows they have to descend along the back of the firebrick arch now invariably fitted in English engines. This still further tends to reduce the efficiency of the lower rows of tubes. Again, the pull of the blast pipe is greatest just at the level of the top rows, making matters still worse. Experiments made years ago in the United States showed that so inefficient are the lower rows that plugging up some 15 per cent. of the whole tube capacity of the boiler did not make 1 per cent. difference in the steaming power of the boiler or its economy. To overcome this difficulty it is necessary that the pull of the blast should be diffused or equalised, so that the hot gases may flow in equal quantity through all the tubes. This is productive of economy in two ways. In the first place, the faster the products of combustion flow through the tubes the less is the time available for giving up their heat. Consequently, anything which will reduce the velocity of flow, other things being equal, the greater will be the economy. In the second place, the more equal the distribution of the hot gases throughout the whole number of tubes, the more efficient will the heating surface be. There is a secondary form of economy which we must not pass unnoticed. The smaller the back pressure the better; but in the locomotive there must always be some back pressure or the draught would not be sufficiently powerful. But the draught depends on the inductive action of the steam escaping up the chimney in practically a continuous stream. Now perhaps the most inefficient way of making use of the exhaust is that generally adopted. Mr. Korting has shown, on the one hand, how by properly constructing what is virtually a blast pipe—we refer to the well-known Korting air ejector—an enormous quantity of air can be moved by a very small quantity of steam; and Mr. Gresham, on the other hand, has shown how, by proportioning the parts of an ejector on scientific principles, almost an absolute vacuum can be obtained by the inductive action of a jet of high-pressure steam. With such facts available, it seems remarkable that engineers have not tried modifications of these systems suited to the locomotive. The whole function of the exhaust is to make the nearest possible approach—within the limiting conditions—to a vacuum in the smoke-box, with the least expenditure of power in the shape of back pressure. It has long been known that the distance between the nozzle and base of the chimney plays an important part in this. It has also been known that an annular jet is more effective than a solid jet, but no advantage has been taken of this.

To return now to the consideration of what is being actually done. We have first Mr. Webb's work. Very little has been made public on this subject, but we understand that he is using two distinct annular blast pipes, combined with a species of breeches pipe, and that each cylinder exhausts into its own blast pipe. The result is that not only is the steaming power of the boiler greatly augmented, but that a very curious action is set up by the alternate exhausts, each one tending to make a vacuum in the other pipe, and we understand that the effect is so marked at fairly high speeds, not only is the back pressure reduced all through the stroke, but the moment the exhaust port opens the pressure falls below that of the atmosphere by a couple of pounds. Mr. W. Adams, working on independent lines, has adopted a blast pipe which we have illustrated in our impression for August 13th, 1886. This is intended to equalise the draught through the tubes. The exhaust pipe is swelled out low down in the smoke-box, and a species of trumpet mouth is fitted to it facing the lower rows of tubes. The exhaust is annular. We understand that the results obtained are admirable, but no definite figures on the subject have yet been made public. In its most recent form the Adams vortex blast pipe is fitted to an engine shown by Messrs. R. Stephenson and Co., at Newcastle. In this the diameter of the internal air nozzle is 5in., the blast space or ring surmounting it being $\frac{1}{16}$in. wide. We shall illustrate this in another impression. The most remarkable advance seems, however, to have been made by Mr. Appleby, locomotive superintendent of the Waterford and Limerick Railway. On another page we have illustrated and fully described in his own words the blast pipe which he is using. It will be seen that he has combined the annular system most ingeniously with an adjustable blast pipe, and he has carried out experiments and published results of those experiments, which we give, which show that he has obtained a remarkable advantage. A goods engine, running with the ordinary blast pipe, burned during the month from February 22nd to March 22nd, 38·78 lb. per mile, with an average load of thirty-one wagons. It was since fitted with his blast pipe, and during the month, April 21st to March 21st, burned 29·94 lb. per mile, with a load of twenty-eight wagons. Equalising the figures to the loads, we find that with twenty-eight wagons the coal consumption should have been about 35 lb. per mile; deducting from this, in round numbers, 30 lb., we have a saving of 5 lb. per mile, or say, 16 per cent. Even if we make some allowance for the fact that the weather was worse February-March than it was April-May, it still appears that an enormous saving has been effected by very simple and inexpensive agency. We have no record, indeed, of a greater saving made by adopting the compound system.

We do not for a moment suppose that the saving is due to a reduction of back pressure alone, though that may no doubt have helped. It is far more likely that it is due to an increased boiler evaporative efficiency. It is to be hoped that Mr. Appleby will see his way to carry out some experiments on this point. There can be very little doubt that the most is not being got out of the locomotive boiler of which it is capable. Unfortunately it has been so good and has done so well that engineers have rested content to accept what they got thankfully, and did not trouble themselves to get more. But an exhaustive series of experiments which might readily be carried out would, we feel convinced, give a good reward; and this applies not only to locomotive engines, but to all boilers which depend on exhaust steam for their draught. It is well known that the fire-box efficiency of such boilers is very much higher than that of the tubes. Efforts ought therefore to be directed to the tubes. The equalisation of current through them, and the reduction of the velocity, are the things needful. While the existing system of blast is retained no progress will be made. But we have little reason to doubt that, as far as the locomotive is concerned, it is doomed.

GAS SUPPLY.

MR. FIELD'S yearly "Analysis" of the accounts of sundry gas companies shows that the capital raised by the three metropolitan companies underwent an increase last year to the extent of £136,000, the total amount at the close being £14,106,000. The Chartered Company is the leviathan of the scene, taking more than five-sevenths of the whole. The gas sold in London exceeded 23,000,000,000 cubic feet, for which the companies received £3,316,000, the actual profit being £1,238,000. Miscellaneous receipts make an addition to this amount, whilst interest on borrowed moneys effects a deduction, the net profit coming out as £1,119,000, or £95,000 more than the sum requisite to pay the standard dividends. But as the companies are charging less than the standard price, they have the privilege of paying an extra dividend, if they can do so, in accordance with the sliding scale established by Parliament a few years back. The additional dividends thus payable last year amounted to £207,000. Towards this there was, in the first place, the surplus of £95,000, which fell short of the required amount by £112,000, to meet which there was an ample resource in the reserve fund and unappropriated profit, represented by £845,000. Falling back on past profits is not a desirable policy. Gas making was not so profitable last year as in 1885, for while the rental was greater, the profit was less by £42,000. Residuals last year brought in only £784,000, as compared with £866,000 in 1885, a deficiency of £82,000. On the other hand, the coal account was in favour of the companies. But gas has been cheapened, the rental last year being less by 0·62 pence per 1000 cubic feet, as compared with the year preceding. This may seem a small reduction, yet it is more than fifty shillings in a million cubic feet. The price charged for 16-candle gas last year ranged from 3s. per 1000 cubic feet down to 2s. 6d., the standard or initial price being 3s. 6d. for the South Metropolitan and 3s. 9d. for the two other companies. The drop in residuals is such that where the companies made 11d. in 1882, they only made 8d. last year. The number of gas consumers in London approximates to 291,000, with an increase of more than 2000 per annum. The gas lamps are 69,000, with a yearly increase of about 1000. The increase in the number of consumers appears inadequate, compared with an addition of 66,000 to the population, and an increase of nearly 9000 in the number of houses. The inference is unavoidable, that a large proportion of the new houses are lit by means of oil. It is a strange conclusion, but if we compare the total of houses in London with the total of gas consumers, we must infer that half the houses in London are without gas. If so, the consumption of oil must be large, and helps to account for the enormous stores of petroleum in the metropolis. While cheap burning oil is evidently keeping gas to a large extent out of the houses of the working classes, the question arises whether the gas companies might not cultivate a trade in this direction, and thereby strengthen their position as menaced by the electric light. The latter is most likely to compete with them among the larger class of consumers. For the present the electric light has a struggling kind of existence, but it is making some headway, though not in such a manner as to produce a marked impression on the revenues of the gas companies.

In addition to the statistics of the metropolis, there are those which relate to the suburbs and the provinces. Mr. Field analyses the accounts of twelve suburban companies and ten provincial companies, besides those of nine gas undertakings conducted by local authorities, the latter being the Corporations of Birmingham, Bolton, Halifax, Leeds, Leicester, Manchester, Nottingham, Oldham, and Salford. The idea that local authorities are specially qualified to deal with the gas supply is only partially borne out by these statistics. The capital employed by the metropolitan companies is at the rate of 12s. 3d. per 1000 cubic feet of gas sold, while the Corporations required 13s. 10d. The suburban companies employ 13s. 5d., and the provincial companies are the most moderate, their capital being 11s. 6d. per 1000ft. The Corporations are low in the matter of working expenses, and also in the prices charged for the gas. In the net profit per 1000ft. the Corporations are much the lowest, doubtless for the reason that they have no need to make profits for the sake of paying dividends. Yet in the gross profit per 1000ft. of gas the Corporations take a full penny more than the provincial companies. One peculiarity in the Corporation management consists in using gas profits in aid of rates. This was carried last year to the extent of 2⅝d. per 1000ft. on the average among the nine Corporations specified. The largest appropriation of this nature was in the case of Salford, where it amounted to nearly 5⅝d. per 1000ft. The highest absolute amount was at Manchester, where it reached £52,000. But £24,454 was also required for the sinking or redemption fund, and the total is shown to exceed the net profit by as much as £27,972. At Oldham we find that £2544 of gas profits went in aid of the electric light. To the presence of the electric light we may probably attribute the exceptional circumstance that the sale of gas in Oldham last year fell off by nearly 1½ per cent. Another feature in the accounts of the nine Corporations consists in the amount of interest paid for borrowed capital. Last year the metropolitan companies paid interest to the extent of 1½d. per 1000ft. of gas sold, while the Corporations paid at the rate of nearly 6d. for annuities and interest on borrowed moneys. The decline in the value of the residual products of gas-making affects all gas undertakings. In 1883 the Corporations realised 75 per cent. of the cost of coal by the sale of the residuals. Last year they realised less than 49 per cent. The Commercial Company, in London, is exceptional in the circumstance that while in 1883 it recovered under 60 per cent., last year it obtained a mere fraction less.

It seems strange that the waste of gas has undergone no material reduction within the last five years. Going back to 1874, we find that the percentage of gas unaccounted for was much greater than at the later date. Still the present loss is large, exceeding in the metropolis 5 per cent. of the make, the actual quantity being larger than the entire volume sold in Nottingham. More than 120,000 tons of coal per annum are thus burned to waste in London. Allowing that some of the gas may be stolen, and that the meters fail to register all that passes through them, the loss is still considerable. Concerning some of the comparisons, it should be observed that there is a variation in lighting power. Common gas in London has, by statute, an illuminating power of not less than sixteen candles. Among the twelve suburban companies, Richmond has a standard of fifteen candles, and all the rest only fourteen. Among the nine Corporations, there is a considerable range in the legal standard, and the figures make it appear that the authorities give very much better gas than the law requires of them. As we presume the gas is tested by their own officials, it would be a matter of some interest if an independent test were applied, so as to verify the fact that Nottingham gives 19-candle gas instead of 13½; Oldham, 19·50-candle gas instead of 14; and Birmingham, 17·32-candle gas instead of 15. The provincial companies do not profess to be so generous, though two or three of them run rather high. In London, where the gas supplied by the companies is tested by the Metropolitan Board and the Corporation, the observed lighting power is less than a candle above the legal standard. Among the results worthy of note in the history of the London gas supply, as exhibited in Mr. Field's annual "Analysis," we find the following: — The capital employed in the manufacture of the metropolitan gas supply in 1869 was considerably under £8,000,000, whereas it now exceeds £14,000,000. But the proportion per 1000ft. of gas has fallen from 15s. 10d. to 12s. 3d., and the working expenses have declined from 18·05d. to 13·72d. While dividends have been maintained, the price of gas has been lowered and the quality improved. Legislation has protected the consumer, and does not appear to have injured the companies.

STEAM ENGINE ECONOMIES.

THE steam engine as a whole—that is to say, engine, boiler, and condenser—uses in the production of power two fluids, a liquid, and a solid. The fluids are air and steam, the liquid is water, the solid is coal. Of these, the air, coal, and water all leave the apparatus at a higher temperature than they entered it. They must therefore be prefixed by the negative sign —. The steam leaves the engine at a lower temperature than it entered it. Therefore it must have prefixed to it the positive sign +, because the performance of work depends on the loss of heat, and of temperature, which are two different things, of the materials employed to perform work. With the steam we need not now concern ourselves. The well-known formula $\frac{T - t}{T}$ expresses the efficiency of the engine. A moment's reflection will show that everything put into the apparatus cold and taken out hot represents a loss of efficiency. The three cold things are the coal put in the furnace; the air used to burn that coal; and the feed-water pumped into the boiler. We propose to consider here what economy could be effected by previously heating them all.

We shall assume that the temperature of the furnace is 2000 deg. Fah., which is a moderate assumption, but sufficient for our purpose. Taking the consumption of coal at 3 lb. per horse per hour, and the sensible heat of the coal at 50 deg., we see that our three pounds of coal must be raised through 1950 deg. The specific heat of coal is 0·24; therefore each pound of coal will require to raise its temperature to that of the furnace 1950 × ·24 = 468 units, or, for 3 lb., 1404 units. But 3 lb. of coal will develope about 42,000 units, the amount varying with the quality of the coal. Therefore, heating the coal up to furnace temperature demands about one-thirtieth of all the heat generated, or, say, over 3 per cent. About 18 lb. of air are usually required to burn a pound of coal, or, for 3 lb., 54 lb. of air. The specific heat of air is 0·23. Consequently, assuming the air to have a temperature of 50 deg., we shall have 1950 × 54 × ·23 = 24,219 units, or more than one-half of the whole heat generated by the fuel. Of this heat, however, a large proportion is surrendered subsequently to the water in the boiler. The escaping products of combustion go away, however, at a high temperature, varying between 400 deg. and 600 deg. Taking the latter as probably that in an engine using 3 lb. of coal per horse per hour, we have 550 × 54 × ·23 = 6831 units wasted, or, in round numbers, a little over one-sixth of the whole heat generated, or very nearly 17 per cent. If, then, it was possible to raise the temperature of the air entering a furnace to 600 deg. for each 100 lb. of coal used with cold air, 83 lb. would suffice with the hot air. This is a very considerable saving, and it is a curious fact that so little has been done to secure even a part of it. Attempts have been made at various times—as, for example, on certain boilers in Woolwich Arsenal and by Mr. Alexander, of Cirencester—to raise the temperature of the air by using up waste heat, and these attempts all met with a certain success. The most elaborate attempt which has been made, however, in this direction took the form of an experiment carried out for more than three years, beginning in the summer of 1881, at the chemical works of the Pacific Mills, Lawrence, Massachusetts, under the direction of Mr. J. C. Hoadley. The description of this experiment occupies a quarto volume of 173 pages, published by Wiley, of New York, and Trübner, London, in 1886, to which book we must refer our readers for details. The apparatus transferred a part of the heat of the waste gas to the air entering the furnace. The boiler tried was one of fifty, all alike. They are externally-fired return tube boilers, 5ft. in diameter and 21ft. long over the smoke-box, which is 1ft. long. The tubes are 20ft. long, 3·5in. diameter, arranged in seven horizontal rows—four rows of eleven tubes each, one of nine, one of seven, and one of five, making sixty-five tubes in all. The fuel used is anthracite and bituminous coal. The grates are 5ft. 4in. wide. The heating apparatus consisted of tubes about 18ft. long, arranged in a species of oven turned over the boiler, through which oven the heated products of combustion escape. It is impossible to reproduce even in part the elaborate particulars of the results as given by Mr. Hoadley. It must suffice to say that the ordinary boiler had an efficiency, measured for the whole week's work day and night, of 68·87 per cent. with anthracite, and with bituminous coal of 64·61, while with the warm air the efficiency rose with anthracite to 79·2 per cent., and with bituminous coal to 74·96 per cent. The temperature of the escaping gas was 368 deg. entering the heater, and 189 deg. leaving it. The temperature of the air supplied to the furnace was 315 deg. This result was obtained, of course, by making the air and the hot gas travel in opposite directions. A blower was employed to propel the air through the heating apparatus. This consumed about 1 per cent. of the whole power of the engine. Summing up the results, Mr. Hoadley says: "It therefore appears that the net saving effected by the warm blast was from 10·7 to 15·5 per cent. of the fuel used with cold blast, which is the same thing as to say that discontinuing the warm blast would cause an increased consumption of fuel equal to from 12·3 to 18·9 per cent. of the quantity used with hot blast." Thus it will be seen that practice very fairly corresponds with the theoretical proposition we have laid down.

It will be freely admitted that a saving of 10 to 15 per cent. in coal bills is of great importance, to say nothing of the reduction in the amount of smoke produced. The first cost of the apparatus, the space occupied, and the wear and tear, are items which, however, must not be overlooked. The apparatus used at the Pacific Mills worked for two years, at all events, uninterruptedly without requiring any repairs or renewals, and was last year in good order, with "some indications of reasonable durability." But it must not be forgotten that if the waste gases are used in this way, they cannot also be available for heating the feed-water, as in a Green's economiser. The steam user will have to choose between the two systems, and sometimes the one, sometimes the other, will commend itself to him. When space is not of much moment, there is a system of heating the air which is at once very inexpensive and extremely durable and efficient. It consists simply in using good bricks, not necessarily fire-bricks, as a regenerator on Siemens system. The hot gases are first passed through one stack of bricks for an hour, and then through another. The air supply is in like manner passed alternately through each stack. The system is so well understood, and so simple, that we need not explain it. The results likely to be obtained are so good, and the cost of the plant so small, that it is remarkable that it has not been freely adopted. To a certain extent, the draught will be affected, but in many cases there is enough draught and to spare, and in others a fan or blower will supply all the air wanted. The most expensive means of obtaining a draught that can devised is a highly heated chimney.

In just the same way that the loss by using cold air and the gain to be obtained by employing hot air is calculated, we can ascertain the gain to be had from heating feed water. The liquid enters the boiler at 50 deg., let us say, and leaves it as steam at 300 deg., corresponding to a pressure of 52 lb. per square inch. In order that this may take place, each pound of feed-water requires 1155 units. If the feed entered the boiler at 300 deg., then in the boiler it would need to receive but 905 deg. The difference between 905 and 1155 units represents the saving to be effected by raising the temperature of the feed-water. In other words, by imparting 250 units per lb., and so raising it from 50 deg. to 300 deg., a saving of about 27 per cent. is effected regarding the matter in one way, and about 22 per cent. regarded in another way. That is to say, for every 100 lb. of coal used with hot feed, 127 lb. would be used with cold feed; and for 100 lb. used with cold feed, 78 lb. would suffice with hot feed. The advantage to be thus gained is fully appreciated on land, where plenty of space is available for heating feed-water in "economisers;" non-condensing engines also heat feed-water by the waste steam; but at sea, where such a saving would be more than ever desirable, nothing has been done in this direction worth naming. If by the aid of heat otherwise wasted the temperature of the feed could be raised to 369 deg. Fah., a saving would be effected as compared with the existing plan of about 25 per cent. This is just what is claimed for the triple engine as compared with the ordinary compound. If it is worth while to incur the enormous outlay rendered necessary by altering engines or replacing them, surely it is worth while to stretch out our hands to grasp the saving which can be made in another direction. It was recently estimated that the introduction of the triple expansion system would involve an outlay of one million sterling per annum for some years. If 25 per cent. can be saved on the ordinary compound by substituting triple-cylinder engines, and 25 per cent. more by heating the feed-water, it is obvious that the new system would require only half the fuel used under the old. We do not venture to assume that so excellent a result would be realised in practice; but it does seem at least certain that to risk a few thousand pounds in experimenting would not be rash speculation. As to the argument that room would be required, it is enough to answer that less boiler space would be needed. If we do not do it in this country, then it will be done abroad, and English shipowners will hold up their hands and say, "How is it *we* never thought of this?"

THE CLARK PROCESS FOR BRISTOL.

THE inhabitants of Bristol have been trying to obtain powers to derive their water supply from the Severn Tunnel water, but for reasons mysterious in the extreme our leading chemists seem to have determined not to let them. It appears that the water in question contains magnesia in considerable quantities, but can be easily softened by the well-known Clark process, as indeed Professor Wanklyn testified. The Bristolians therefore proposed to have this process applied to the Severn Tunnel water before using it. For reasons, however, which we will not for the credit of chemical science enter into, the eminent chemists arrayed on the other side, and engaged as scientific experts to give evidence against the Bill, were practically unanimous in stating that the Clark process would not be of any value in softening this water. Dr. Tidy indeed maintained that "when you adopt Clark's process, with the greatest possible care, you cannot reduce the magnesia by more than one-fourth," and was prepared to vouch that Professor Dewar would give similar evidence. Dr. Frankland, sen., supported these statements by speaking from work done by himself or his assistants, and Dr. Odling spoke in general terms to the same effect. The strange thing about this evidence is that it appears to be at variance with the facts, which moreover are easily proved by direct experiments. The analyses of the Severn Tunnel water in its natural condition will give the following results:—Carbonate of lime, 13·6 grains per gallon; carbonate of magnesia, 5·4; sulphate of magnesia, 3·2; nitrate of magnesia, 0·6; chloride of magnesia, 0·8; chloride of sodium, 3·5; total, 27·1. After being softened by the Clark process by Professor Wanklyn in his laboratory, the softened water contained only 9½ grains of solid matter per gallon, and of these 1·57 grains were lime and 1·44 magnesia, showing that the Clark softening process answered perfectly well with that description of water. The accuracy of this analysis is no doubt beyond question; but it is nevertheless possible that the chemists who gave their evidence against the adoption of the Clark process may have been led to such totally different results by a kind fate that wished to make their work as scientific experts for the side they were engaged by, as easy and as harmonious with their conscience as possible. At the same time, it is very curious that some of these gentlemen when cross-examined did not come out of the fire as well as one could have wished such eminent chemists to do. It appeared, for instance, that Dr. Frankland, sen., had not conducted his experiments himself, that his figures would not work, and that he had entrusted the whole matter—a very important one it must be admitted, bearing as it does so closely on the health and comfort of thousands of people—to an assistant. This flippant and careless attitude is the more to be regretted as some system of artificially softening water is becoming every day more and more indispensable. Our industries are suffering in many instances from the hardness of our water. The numerous inconveniences which are suffered by London alone on account of hard water are incredible. Health and wealth are both sacrificed to this Moloch of our time, which chemists seem to have agreed to support and defend. We will not enumerate the many difficulties encountered by the users of this fluid, but we cannot refrain from expressing considerable surprise that the Clark process, which has been known to everyone for thirty years, and which has been adopted with great success in many cases, should not be more largely used. The adoption of this process involves an outlay of a fraction of a penny per thousand gallons, its actual value to the community may often be counted by shillings per thousand gallons, and its non-adoption may mean that industries which might otherwise flourish do not even spring up. The sooner some cheap system of softening water is adopted the better. The methods of utilising the Clark process which have been brought out during the past few years have no doubt done a good deal towards reducing the system to a practicable one, and to overcome the difficulties which are inherent in the system as Clark left it; but it has nevertheless at present gained but little ground, and there are perhaps not more than half a dozen towns using it.

THE EYEMOUTH HARBOUR.

IN December last we gave a description of the works which had recently been completed, forming an excellent little harbour, more particularly for the fishing trade of the coast. The works cost about £25,000, and everyone interested expected very great facilities and commercial results, the only work remaining to be done being the removal of part of the outer harbour bar. It is now nearly two years since the harbour was opened. When the scheme was embarked upon it was with the intention of providing a harbour into which boats could be run at all heights of the tide. An excellent harbour was made, but before it was entirely completed the money, which had been lent by the Public Works Loan Commissioners, became exhausted, and the bar was left in the same condition as formerly. The fishermen admit that the harbour is first-rate, but complain bitterly that, after having been saddled with this heavy debt and landing dues, which they did not formerly pay, they are no better off than before. They cannot enter the harbour three hours before or after high water, thus losing time and the market. It appears that the Loan Commissioners cut down the original designs to the lowest possible proportions, and the loan granted allowed hardly any margin even for the works as reduced. Owing to different causes which were unavoidable, the trustees had spent all the money before commencing the entrance channel works. They then asked the Loan Board for other £3000, which would have sufficed to finish the channel; but this the Board refused to give. Of course this policy is very suicidal, as there is small prospect of any interest being paid on the money spent if the boats find a difficulty in getting into the harbour. It looks rather as if the Loan Board would be glad to have another financial failure, as it will form an additional argument against the whole system of loans to harbours, to which they have always been opposed. It would be much better if the money were at the disposal of some board which understands the system and its advantages if properly worked. The entrance channel being left to the last was a necessity from the nature of the works, or of course the engineers would have preferred to have left some of the inside work unfinished until the revenue increased. The dredging and cutting of the bar may be effected by the expenditure of £3000 economically used, with dredgers, assisted by scouring operations, and it seems a very serious thing that a small community should be saddled with a heavy debt for incomplete works, when a comparatively small addition to the present expenditure would make the works of the greatest importance to the community, and repress the present ominous discontent that promises to culminate in refusal to pay dues.

THE BUSINESS SIDE OF THE JUBILEE.

MERCHANTS in the large towns express satisfaction at the results of the Jubilee. A very large amount of money has been "moved." Cash lying idle in the bank has, as the Scotch say, been "lifted" and set in circulation. An immense amount has been expended in labour involved in the preparations for the rejoicings. All the working classes associated with the production of edibles and drinkables have benefited to a great extent; in many instances wages have been doubled. Values of produce, except farm produce—which has rarely been so excellent in quality, and yet so low in price—have been fully maintained. Butchers, fishmongers, poulterers, bakers, and confectioners, have all been literally "pulled out of the place" with work. The gas and electric companies have had their resources taxed to the uttermost to meet the loyal demand for illuminations; the makers of flags, banners, and triumphal trophies; carpenters in erecting barricades, platforms for sight-seeing, temporary buildings for demonstrations, games, &c.; clothiers, drapers, and dressmakers—both sexes desiring to look their best on Jubilee Day—have been utterly unable to meet the exceptional calls upon them; while the noble army of waiters, usually the meekest of men, have been able to adopt the tone militant. The man who got 2s. 6d. a day has been able to command 5s., and thousands have taken to the duty "for this occasion only," so as to earn an honest penny or two. Printers worked night and day to produce programmes, invitation cards, and the hundred-and-one requisites of public and private entertainments; owners of horse-flesh and vehicles for hire had a royal week of it; in fact, it is hardly possible to name a business which has not been stirred to activity by the magnificent outburst of enthusiasm signalising the Jubilee year. Everybody seemed anxious to do something extra in honour of the event, and this was precisely the reason why industry felt its pulse quickened, with, it is to be hoped, more than fleeting effect.

A NOVEL RAILWAY ACCIDENT.

As a timely reminder to those whose business it is to look after the safety of railway travellers, it will not be out of place to mention the painful accident which has just occurred on the Berlin-Potsdam Railway, the third fatal one, it may be noted in passing, which has taken place on the line in recent times. It appears that an empty goods train was prematurely signalled into the station at Waansee, and ran into a standing excursion train, waiting to return to Berlin, when a smash took place which caused the reservoir of gas under one carriage to explode while the locomotive of the goods train caused the gas to ignite, which flew about in all directions and over the cushions, and set fire to everything inside the carriage in which three persons were caged, and could neither escape nor receive assistance from without on account of the build of the carriage, and were in the most incredibly short space of time burnt to an actual cinder. The only remnant of the male passenger appears to have been part of his waistband, by the buttons of which it is hoped to recognise his personality. The obvious moral to be drawn from this sad catastrophe is, that where gas is used on railroads the reservoir of it must be so placed and formed that under no circumstances, can it be smashed by a collision or the gas ignited if such should take place. The gas receiver in this case was a long sheet iron drum, placed transversely beneath a second-class carriage.

THE NEW COINS.

THERE is no doubt that the Mint authorities, or whoever may be responsible for the recent issue of "Jubilee" coins, have played nicely into the hands of counterfeit money makers. There is not one of the denominations which have been tampered with that is creditable—artistically or mechanically—to the Royal Mint, and which may not be easily imitated by professional smashers. In fact, the pieces resemble castings more than coins which have been struck between steel dies, and hence the temptation to manipulators who work with pipkin, ladle and mould. We should advise the public to be on their guard, and to test new coins wherever possible, by weight, before pocketing them. This may be done by placing in the opposite scale-pan a known genuine coin of the old type, and of the same denomination as that to be tested. This really will be the only safe plan for deciding which is the good coin and which the "duffer," for false coiners cannot imitate in weight, however readily they may copy the designs of coins of the precious metals. The new sixpences have already been withdrawn. They have been freely gilt and passed as half-sovereigns. As many as thirty were found on one individual during the present week.

LITERATURE.

An Elementary Treatise on the Mathematical Theory of Perfectly Elastic Solids, with a short account of Viscous Fluids. By WILLIAM JOHN IBBETSON, M.A. London: Macmillan and Co. 1887.

THE present work gives an account of the mathematical theory of Elasticity, and forms, consequently, a complementary treatise to the "History of the Elasticity and Strength of Materials," begun by the late Dr. Isaac Todhunter, and completed by Professor Karl Pearson, recently reviewed in these columns. The style of the book addresses itself principally to mathematicians, especially of the Cambridge school, where the book will be useful as a much-needed standard treatise; but we doubt whether it will repay the practical engineer, unless he has a proclivity for such treatment, to spend much time on these analytical developments. The conclusion arrived at from a perusal of the book is that the problems which are capable of complete analytical solution are, with few exceptions, of theoretical interest; while, on the other hand, the problems which the engineer submits for solution lead immediately to such analytical complication as to be theoretically insoluble, the bodies and shapes which the engineer designs being rarely of a simple mathematical form. The engineer in such cases of difficulty turns up generally the empirical formula given in his pocket-book, and when this formula is carefully examined as to its theoretical basis, we shall generally find that it is founded on the assumption of what is called "homogeneous strain and stress" in this book, following the terminology of Thomson and Tait's "Natural Philosophy." Mr. Ibbetson has done well in his treatise to give in Chaps. II. and III. a careful analysis of such "homogeneous strain and stress," illustrated by careful diagrams drawn to a good large scale.

According to the "principle of superposition," permissible when the strains and stresses are small, a homogeneous strain or stress is the resultant of linear strains or stresses in three rectangular directions. Given that the stress is a uniform linear tension, the strains consist of a simple extension in the direction of the tension, and a simple compression in lines perpendicular to the tension; and given that the strain is a uniform linear extension, the stresses consist of a linear tension in the direction of the extension, and pressures in lines perpendicular to the extension. In order to connect these strains and stresses, the values of the elastic moduli as determined by experiment must intervene, and it is now found simplest, following Thomson and Tait, to express these moduli for an isotropic substance in terms of two, namely, the "*elasticity of volume*," denoted usually by k, and the *elasticity of figure*, or the *rigidity* denoted by n. Much confusion in the mathematical treatment of the subject of elasticity would be avoided if all foreign writers would conform to this terminology.

It will then be found that—Ibbetson, pp. 136, 137—if the stress in an isotropic solid is a simple uniform longitudinal tension P, the strains will be an

extension $\left(\frac{1}{3n} + \frac{1}{9k}\right)$ P in the direction of the tension,

and compressions $\left(\frac{1}{6n} - \frac{1}{9k}\right)$ P at right angles to the tension; but given that the strain is a simple uniform longitudinal extension e, the stresses will be

a tension $\left(k + \frac{4}{3}n\right)e$ in the direction of the extension,

and tensions $\left(k - \frac{2}{3}n\right)e$ at right angles to it.

Once let the practical engineer thoroughly grasp these elementary theorems, and with a slight additional knowledge of the theory of the flexure of beams, he will be sufficiently equipped for most practical purposes with the theory of elasticity.

What the engineer generally calls the modulus of elasticity is the ratio of the tension per square inch to the corresponding extension of a bar of the substance, defining *extension* as the ratio of the elongation to the original length. This modulus is distinguished by mathematicians by the name of Young's modulus, and is the modulus most easily determined by experiment in a testing machine. The above theory shows that Young's modulus is the reciprocal of $\frac{1}{3n} + \frac{1}{9k}$, and is therefore $\frac{9kn}{3k+n}$. Of the two quantities n and k, perhaps n is the most readily determined by experiment, from observation of the shearing vibrations of the substance, and then k is known, from the previous value of Young's modulus; or we may attempt to determine the lateral contraction of the substance, under uniform tension, by careful measurement of the change in diameter of a test piece under tension in the testing machine.

Mr. Ibbetson carefully explains these preliminaries, but uses them only as a stepping stone to the most general case of the general strain and stress in a substance under arbitrarily applied forces and displacements, the most general problem in elasticity for the mathematician, leading to analytical developments of differential equations and curvilinear co-ordinates; but now the author takes leave of the engineer, so far as any practical applications are concerned. The object of the mathematician is now to concoct a physical problem which shall suit the analysis which he has built up, and it is instructive to notice how, as in the cognate subject of hydrodynamics, the conditions to be satisfied at the boundaries form the great impediment to progress; or sometimes, on the other hand, when the boundary conditions are satisfied, to make the equations of internal equilibrium hold.

In Chap. VII. Mr. Ibbetson returns to the practical side of the subject in its connection with the theory of beams, columns, and shafts, and discusses some problems concerning the stability of loaded columns and rotating shafts, of considerable practical interest to the architect and the engineer. The discussion of the effect of the flexure of the spokes of the driving wheels of a coupled engine, and of the elasticity of the side rods, would form an interesting question in its practical bearing on the comparative merits and economy of single and coupled locomotives.

In Chap. VIII., on the equilibrium of plates and shells, the analytical difficulties which intervene render the results again of theoretical importance; but we are surprised not to find an application to an important practical problem, the collapsing pressure of flues and tubes, formerly experimentally investigated by Fairbairn, and recently the subject of a very interesting analytical investigation by M. Halphen.

The subject of Chap. IX. is the investigation of the modification of elasticity on questions of impact, and will doubtless prove interesting but rather short to Mr. Donaldson; here an interesting practical development from the impulse on a rigid obstacle to the impulse of pile driving would have been acceptable. We notice too an omission of the explanation of the modification of the theory of beams, due to difference of moduli for tension and pressure, the theorem claimed by Mr. Donaldson.

Chap. IX. treats of the question of viscosity, and forms a chastening conclusion to the book, if we are to argue from the experiments on steel given in the appendix to Chap. IV., which prove that steel is viscous, like sealing-wax, and only requires time to yield in a similar manner, so that we may live to see the Forth Bridge gradually assume Hogarth or Ruskin's line of beauty, and so gradually reach the water between its 1700ft. spans.

Chap. I. reviews the different molecular hypotheses advanced by Boscovitch, Cauchy, Sir W. Thomson, and others; but it is a relief to find that the author has developed his theories without introducing any molecular ideas, but simply from the straightforward assumptions of the continuity of matter. Chap. II. analyses strains—*i.e.*, deformations; Chap. III. analyses stresses—*i.e*, the tensions and pressures inside a body; in Chap. IV. it is shown how to connect stresses and strains by the intervention of a certain amount of experiment; and now we are in a position to develope our equations as far as analysis will permit us at present. Useful tables are given, connecting the elastic constant in absolute measure and in gravitation measure, as universally employed by engineers. The expression, "weight moduli," of page 201, is ambiguous, and should be replaced by "gravitation moduli."

In conclusion, the book is well printed and the diagrams much better drawn than is usual in mathematical treatises, and generally the whole work reflects great honour on the author, and will prove of great use to the scientific world.

BOOKS RECEIVED.

Les Machines Marines: Cours Professé à l'Ecol d'Application du Genie Maritime. Par A. Bienaymé. Ouvrage Couronné par l'Academie des Sciences. Paris: E. Bernard et Cie. 1887. 4to. 527 pp. Plates.

Tables and Formulas for Switches and Crossings for the Australian Railway Gauges. Calculated by S. Polliter, C.E. Sydney: Turner and Henderson. 1886.

De l'Exploration Economique des Lignes Secondaires des Grands Réseaux de Chemins de Fer dans Différents Pays de l'Europe. Par L. De Busschere, J. De Jaer, et P. Niels. Texte and Atlas. Bruxelles: E. Ramlot. 1887.

Drainage of Lands and Towns. By G. D. Dempsey, C.E. Revised, with large additions, by D. K. Clark, M. Inst. C.E. London: Lockwood and Co. 1887.

An Introduction to Machine Drawing. By David Alan Low. London: Longmans, Green, and Co. 1887.

Annual Report of the Board of Regents of the Smithsonian Institution for the Year 1884. Part II. Washington: Government Office. 1885.

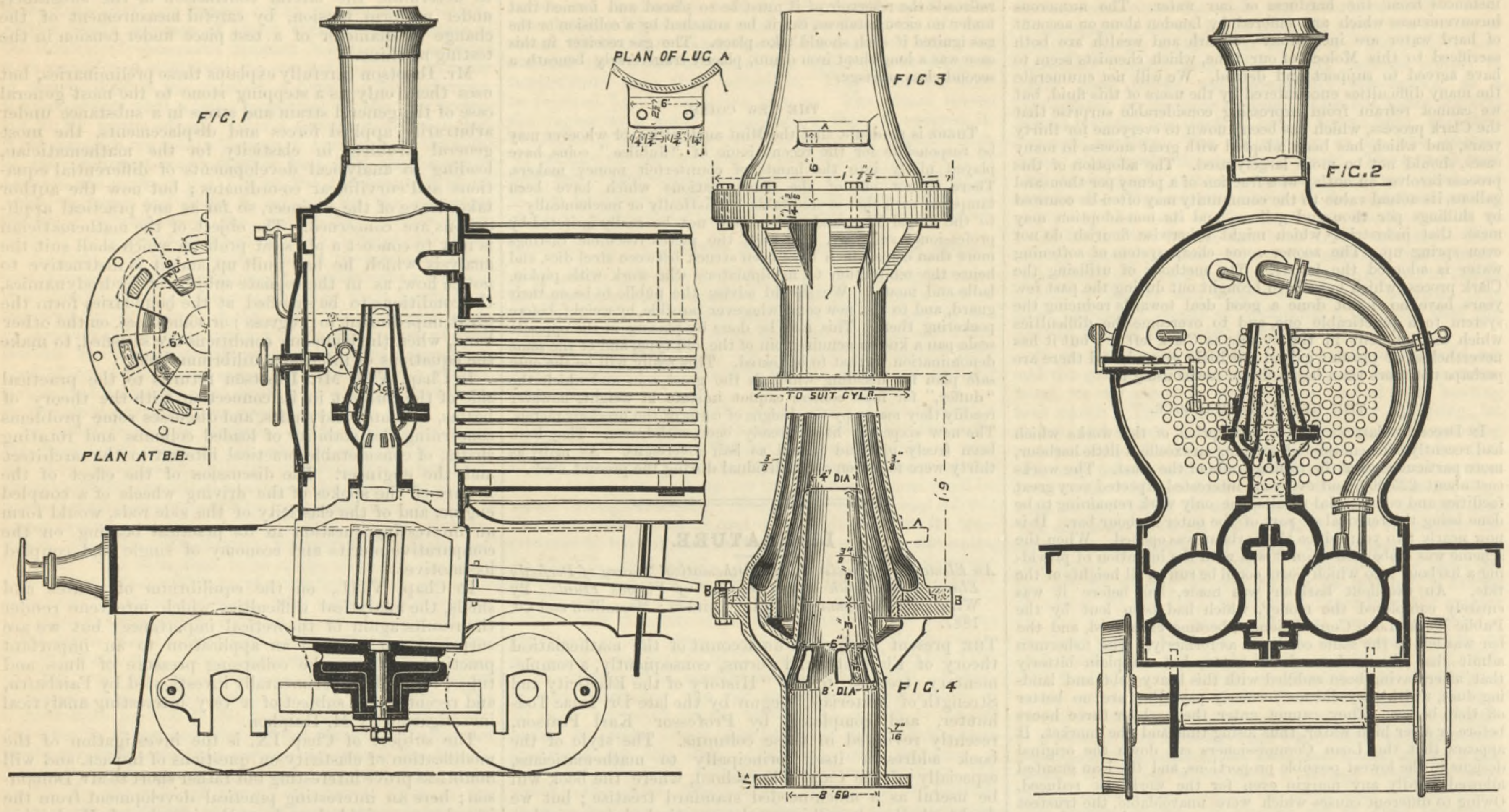
Duncan's Manual of British and Foreign Tramway Companies, and Tramway Directory of 1887. London: Effingham Wilson and Co. 1887.

DOUBLE-CYLINDER COMPOUND PUMPING ENGINE — SOUTHWARK AND VAUXHALL WATERWORKS, HAMPTON.

ON page 10 we publish the first of a number of engravings illustrative of a fine pair of inverted double-cylinder compound direct-acting rotative pumping engines and pumps, designed for the Southwark and Vauxhall Water Company by their engineer, Mr. J. W. Restler, M.I.C.E., for the Hampton pumping station, and constructed by Messrs. S. Moreland and Co., London. The engines have given remarkable results, and have cylinders 32in. and 52·65in. diameter and 7ft. stroke. We shall describe the whole with future engravings.

ADJUSTABLE VORTEX BLAST PIPE, WATERFORD AND LIMERICK RAILWAY.

MR. APPLEBY, ENGINEER.

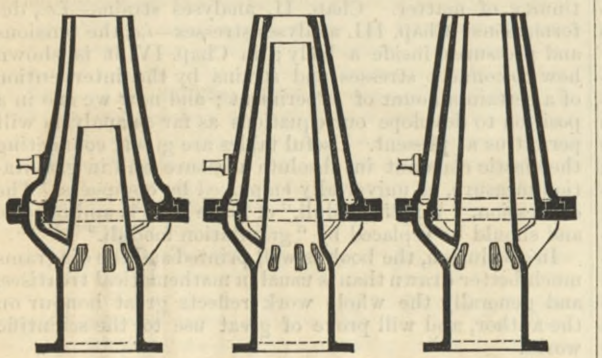


APPLEBY AND ROBINSON'S BLAST PIPE.

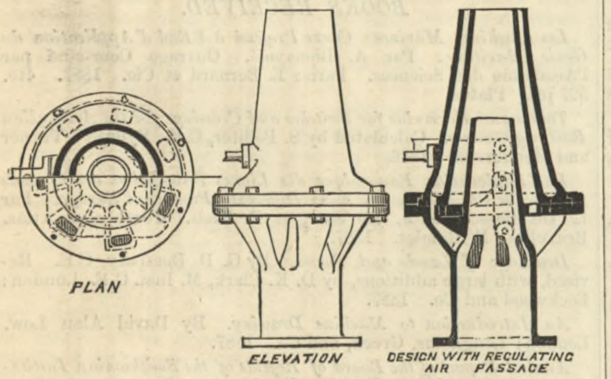
On another page we have referred at length to this invention, in successful use on the Waterford and Limerick Railway. The following description is that of the inventors:—

"This invention relates to improvements in 'Blast Pipes' for locomotives and other boilers, in which a steam jet or blast pipe is employed to secure a draught through the furnace and heating tubes, and in the means whereby such draught may be varied and regulated according to the duty to be performed."

"Assuming blast pipes of design A B or C, as shown on accompanying drawing, to be applied to a locomotive engine, the opening for the intake of air will be about the level of the lower tubes, and it extends upwards to about the level of the upper tubes; the openings here referred to communicate with an annular chamber or air passage surrounding the central nozzle, this chamber is itself surrounded by a casing, the space intervening between the two forming a channel for conveying away



A B C



ADJUSTABLE BLAST PIPE.

steam supplied to the lower end thereof, through passages leading from the central steam nozzle. It will be readily understood upon looking at design A and B, the air is drawn up from the bottom and intermixes with the steam, and can be arranged to either intermingle within a few inches at the bottom or top of the pipes, or any position between the extreme bottom and top of the blast pipe, which may be found most suitable for the class of boiler; the blast pipe having to generate steam or exhaust air. In design C the annular stream of air discharged is both lined with and enveloped by steam. The external casing is formed with a seating, and it is mounted upon the lower portion of the apparatus in such a manner as to be capable of being rotated. In its seat are formed ports corresponding with the passages leading from the central nozzle. When the ports coincide with the passages, steam is free to escape by the annular passage, but upon the external casing being rotated, the supply of steam to the external or annular passage is partially or wholly intercepted, and the collective area of the steam passage or passages is diminished, with the effect of intensifying the blast and increasing the draught, and thereby generate steam that could not be otherwise obtained. By means of suitable connection the external casing may be rotated and the action of the apparatus regulated from the foot-plate of locomotive, or other conveniently accessible position.

"Engineers will at once see the true value of this invention, not only for generating steam under extreme circumstances, but the great saving of fuel effected by having means to regulate the blast upon the fire, combined with the increased heating surface obtained through the lower tubes, which have hitherto been only partially operated upon by the ordinary blast pipe. By this arrangement the exhaust steam is allowed to escape at a lower velocity than with the ordinary pipe, reducing the back pressure upon the pistons, and undue strain upon the motion. For shunting engines, local traffic, and trains with frequent stoppages, these pipes are invaluable, as the engine will generate ample steam for all requirements with the two orifices open. From results already obtained we find a direct saving in the consumption of coal of at least 6 lb. per mile, and from experiments now conducting, we have no hesitation in saying the saving will be further increased."

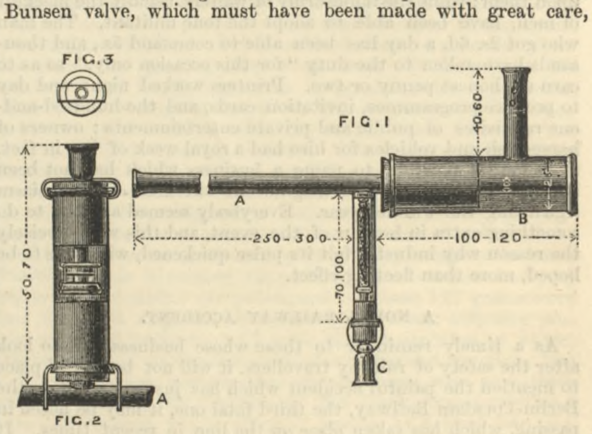
W. and L. Railway.—Comparison of Coal Consumption in Locomotives Fitted with the Ordinary Blast Pipe and Appleby and Robinson's Patent Regulating and Combined Regulating and Vortex Blast Pipe.

Description of blast pipe, &c.	Miles run. Train.	Miles run. Shunting.	Miles run. Total.	Coal consumed. Total cwts.	Coal consumed. lbs. per mile.	Average load vehicles. Pass.	Average load vehicles. Goods.	Average load vehicles. Total.	Cost for 30,000 miles at 13s. per ton.
No. 27 engine, four wheels coupled 5ft. 3in. diameter, 16in. by 24in. cylinders:—									
With ordinary blast pipe, 4¼in. diameter	1311½	231	1542½	394	28·61	4	14	18	249 1 0
With patent regulating and vortex pipe	825	153	978	170	19·46	3	12	15	169 7 10
			Saving effected at 30,000 miles per annum.						£79 13 2
No. 1 engine, six wheels coupled, 4ft. 6in. diameter, 17in. by 24in. cylinders:—									
With ordinary blast pipe, 4¼in. diameter	2010	202	2212	766	38·78	1	31	32	340 16 7
With patent regulating and vortex pipe	2051½	130	2081½	583	29·94	1	28	29	260 12 4
			Saving effected at 30,000 miles per annum.						£80 4 3

Hassendean Cottage, Gloster-place, Windsor, June 27th, 1887. G. MITCHELL.

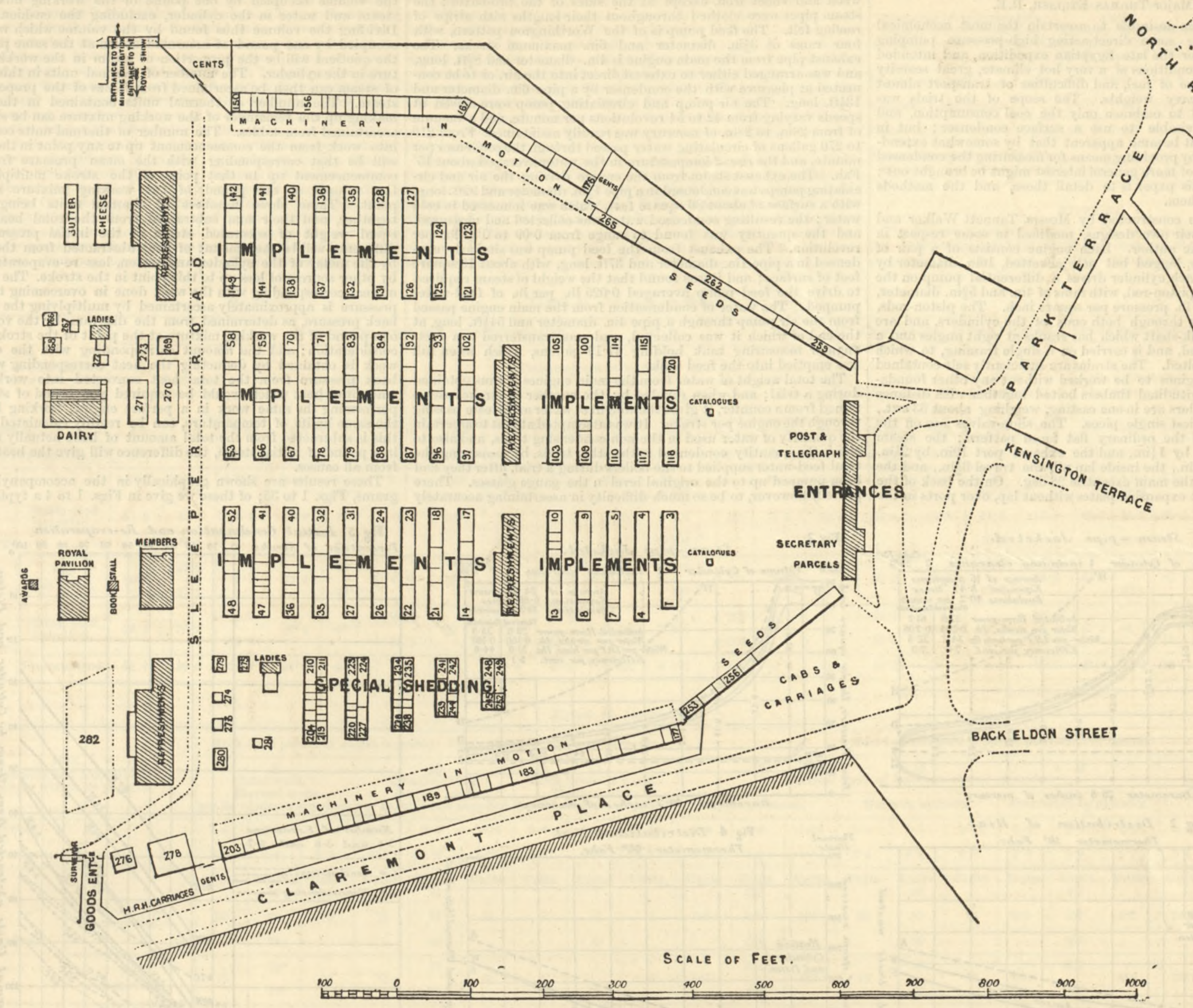
A SIMPLE AIR PUMP FOR USE IN THE LABORATORIES OF WORKS, &c.

The pump here illustrated is described by O. N. Witt—*Chem. Zeit.* 10, 760—in which he reviews the different kinds of air-pumps at present in use. The one here described does not, as the two kinds generally employed in laboratories, require either a strong pressure of water or a long column of discharged water. Now, as one or the other of these requisites is not often to be found in works, the author has constructed a pump the principle of which depends on the hydraulic ram. It can be looked upon as a modification of Jagno's pump, the theory of which has been explained by Mendelejeff, Kupitschoff, and Schmidt—*Annalen*, 165, 63. Jagno's pump works with a column of water, and falls 1½ metres high. If the pressure is stronger the fall may be successively shortened to 40 cm.; if smaller it must be correspondingly lengthened. These are very modest requisites, and the only reason why this pump has found so little favour in laboratories is due to its liability to get out of order, and Linneman's—*Annalen*, 177, 295—improvement on that pump is somewhat expensive. The accompanying Fig. 1, which we take from the *Journal of the Society of Chemical Industry*, will readily explain the construction of the pump as recommended and used by the author for several years. A is a T-shaped glass tube 10 mm. wide, the lower end of which, as also the end of the side piece, is widened out. The upper end is carefully ground. B is also a T-tube, consisting of a piece 25 mm. in width, and a piece of the same tubing as used for A. All three extremities of B are widened out. A is connected with B by means of a very good cork stopper—not caoutchouc—which should be as long as possible and very compact. A should fit into B in such a way that both tubes are perfectly concentric, and that while A can slide perpendicularly but with strong friction in B, the possibility of an oscillation in a lateral direction is altogether excluded. The upper opening is closed by means of a perfect membrane of sheet caoutchouc 5 mm. thick. As it is not easy to obtain perfect caoutchouc, and the least fault may cause it to split, it is best to tie two or three thinner sheets, one over the other, on to the tube. The thickness of the sheets employed should depend on the water pressure at disposal, and must be tried in each special case. A must be pushed into B so far that the water which enters at b, while slightly lifting the caoutchouc sheet, is jerked out at a. Under ordinary circumstances this occurs when, on blowing into b, a loud sound resembling a blast from a trumpet is heard. C is a Bunsen valve, which must have been made with great care,



and should fit perfectly. It should, moreover, be so small that it works easily in the tube, and offers a sufficient passage for the expelled air. As the whole pump oscillates very considerably when in action, the junctions must be tied with silk and thin wire, and fastened so thoroughly that the various parts cannot be displaced. Much depends on the good quality of the small valve; it is not easily made, and the black tubing which is used for it gradually loses its elasticity. It is therefore

PLAN OF THE IMPLEMENT YARD AT NEWCASTLE.



advisable to replace it by an arrangement such as the one shown in Fig. 2. This consists of a wide piece of tubing, which is drawn over and attached to the shortened adjoint piece of A by means of a cork. A thin piece of tubing ground in front is passed through the other end of the wide tube, and on the former glides a somewhat broader but short tube, widened at each end, over the front opening of which a strip of caoutchouc cloth is stretched—Fig. 3—just broad enough to cover the opening of the small tube.

THE NEWCASTLE SHOWYARD.

THE agricultural engineering world has once more prepared for, and is hoping for tangible results from, a Royal meeting. The locality of the meeting has changed from the rural, to the mining and manufacturing North. The implement yard, as shown by the plan above, presents a familiar though modified arrangement. At Newcastle there are five distinct thoroughfares made amongst the shedding, and the length of ground covered is less than usual. Fronting the entrances runs the main avenue through the centre of the yard. The two blocks forming this highway are the two principals in the whole of the implement section. They contain fourteen sheds, and are like the smaller block to the right, containing in all 9 sheds, devoted to the department know as "ordinary" shedding. The numbers, as will be seen by reference to the plan, run from 1 to 149, the following number, 150, being the first in the machinery-in-motion department, which skirt the "ordinary" shedding on the extreme right and left. The right takes up the sequence of the numbering, and contains 150 to 176. Directly across the yard will be found machinery-in-motion stands from 176 to 203. The trial yard is to the left of that shown in our engraving, and runs parallel with, but outside, the cattle part of the yard and on the Claremont-road. The dairy this year has some novelties in dairy implements, irrespective of some machines which are familiar to visitors. Messrs. E. R. and F. Turners' "Gippeswyk" type of vertical engine will this year provide the necessary power to work the machines requiring it.

At the meeting of the Council of the Society on Wednesday, Mr. Bowen-Jones presented the report of the Implement Committee, from which it appeared that they recommended that the trials of potato raisers should take place after harvest, the details of arrangements to be decided by the stewards and judges at the time of the show, and that such information be communicated to the exhibitors. They also recommended that the potato raisers entered for trial and selected by the judges should remain in the possession of the exhibitors up to the time of trial, and any exhibitor whose machine should be selected by the judges, and who did not produce it at the time, should forfeit £10 for each machine not thus submitted.

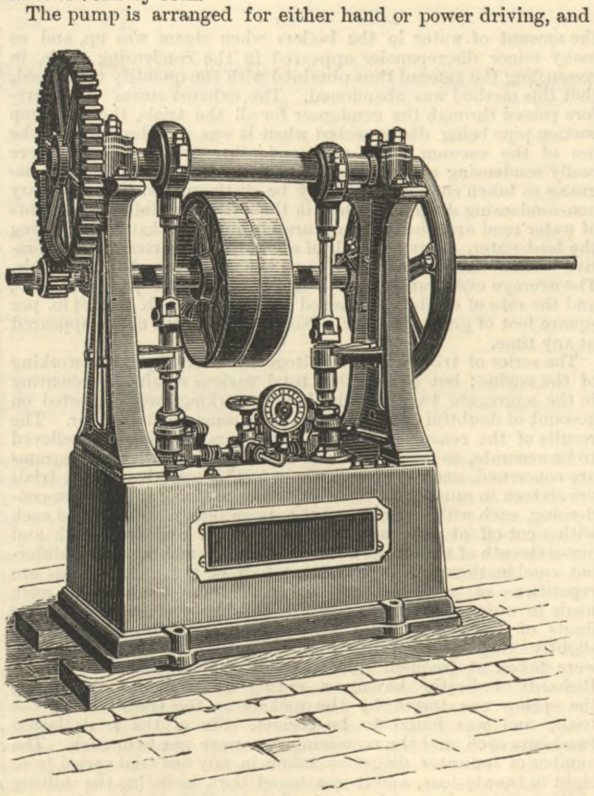
Mr. Anderson had reported that Sir Frederick Bramwell and himself had compiled a complete syllabus of the trials of engines at the Newcastle show, and that copies had been forwarded to the competitors.

From the report of the Showyard Contracts Committee it appeared that the Newcastle showyard works are in a sufficiently forward state, the implement portion being complete, and many of the exhibits in position. The Local Committee have completed the sleeper roads across the showyards, and also to the entrances. The whole of the water-pipes are laid. Satisfactory arrangements for the decoration, both floral and otherwise, of the Prince's tent have been made.

HYDRAULIC BALING MACHINERY.

THE hydraulic pump and press illustrated have recently been supplied by Messrs. John Birch and Co., of Liverpool, for shipment to a distant eastern port. They are designed for pressing hides into bales of 84in. by 42in., and rugs into bales of 78in. by 35in.

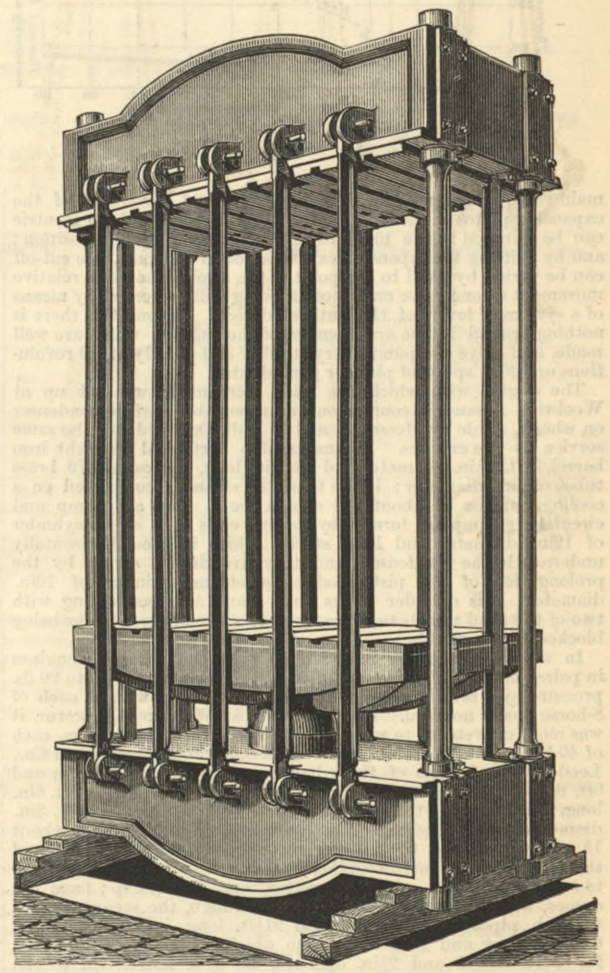
The pump is arranged for either hand or power driving, and



HYDRAULIC PUMP.

is capable of working one or a series of presses, or an accumulator. Speed and power were both specially aimed at in its construction, and so as to effect these purposes in the most efficient manner it is arranged as a double-throw pump, with rams of different diameters.

The press is fitted with T-iron guide bars for holding in the bales whilst being pressed, these guard bars being so arranged as to enable the two different sizes of bales mentioned above, or, if need be, three different sizes, to be made in the one press, this arrangement being rendered necessary in this instance owing to the packers having to make up hides one portion of



BALING PRESS.

the day and rugs the other. When the bale is made, the bars at the front of the press can be removed, or swung up and down on pins as is most convenient. The press top and rising table have grooved boards fixed to them so as to allow hoops or ropes to be fixed round the bales.

EXPERIMENTS ON THE DISTRIBUTION OF HEAT IN A STATIONARY STEAM ENGINE.[1]

By Major THOMAS ENGLISH, R.E.

IT recently became desirable to ascertain the most economical method of working some direct-acting high-pressure pumping engines, supplied for the late Egyptian expedition, and intended for use under the conditions of a very hot climate, great scarcity of water, high price of fuel, and difficulties of transport almost prohibitory for heavy weights. The scope of the trials was originally intended to embrace only the coal consumption, and whether it was advisable to use a surface condenser; but in carrying them out it became apparent that by somewhat extending the series, and by providing means for measuring the condensed water, some results of more general interest might be brought out; and the object of this paper is to detail these, and the methods adopted to obtain them.

The engines were constructed by Messrs. Tannett Walker and Co., Leeds, from their own designs, modified in some respect in consultation with the author. Each engine consists of a pair of horizontal cylinders, lagged but not jacketted, 16in. diameter by 18in. stroke; and each cylinder drives a differential pump on the prolongation of the piston-rod, with rams of 4in. and 5⅝in. diameter, working up to 700 lb. pressure per square inch. The piston-rods, 2¼in. diameter, pass through both ends of the cylinders, and are connected by a crank-shaft which has cranks at right angles and a fly-wheel on each end, and is carried on a single framing, to which the cylinders are bolted. The strains are sufficiently self-contained for enabling the engines to be worked without any other foundation than three longitudinal timbers bolted together with distance blocks. Both cylinders are in one casting, weighing about 33 cwt., and this is the heaviest single piece. The slide-valves are on the outside, and are of the ordinary flat faced pattern; the steam ports measure 10in. by 1¼in., and the exhaust port 10in. by 2½in. The outside lap is ⅝in., the inside lap nil, the travel 3⅜in., and the angular advance of the main excentric 28 deg. On the back of the main valve work flat expansion plates without lap, over ports in the main valve which measure 10in. by 1¼in.; and the travel of the expansion plates on the main valve is 3⅞in. The expansion excentric can be clamped to the main excentric in any required position; and by shifting the expansion excentric round the shaft, the cut-off can be varied by hand to any point of the stroke, the same relative movement of one valve on the other being still preserved by means of a system of levers of the author's design. Beyond this there is nothing special in the arrangement of the engines, which are well made, and drive the pumps very steadily and quietly at 40 revolutions or 120ft. speed of plunger per minute.

The engine with which the trials were made was set up at Woolwich Arsenal in connection with a portable surface condenser on wheels, made by Messrs. J. and E. Hall, Dartford, for the same service as the engines. It consists of a horizontal wrought iron barrel, 2ft. 3½in. diameter and 9ft. 9in. long, enclosing 379 brass tubes of ⅝in. diameter; inside these the steam is condensed on a cooling surface of about 604 square feet. The air pump and circulating pump are formed by the two ends of a single cylinder of 12in. diameter and 14in. stroke, which is fixed horizontally underneath the condenser, and they are driven direct by the prolongation of the piston-rod of a steam cylinder of 10in. diameter; this cylinder works on a crank axle connecting with two of the road wheels to act as fly-wheels, the whole machine being blocked up for working.

In actual use it was intended to work the pumping engines in pairs, each pair being supplied with steam of 80 lb. to 90 lb. pressure by a set of twelve multitubular boilers on wheels, each of 8-horse power nominal. For the trials at Woolwich, however, it was more convenient to substitute three multitubular boilers, each of 40-horse power nominal, made by Messrs. John Fowler and Co., Leeds. The barrels of these boilers are 4ft. 1in. diameter and 9ft. 6in. long; they have copper fire-boxes, 3ft. 5in. wide by 4ft. 6in. long, and 5ft. deep to the bars, and contain 58 brass tubes, 3in. diameter and 10ft. long. The grate area in each boiler is about 15 square feet, and the heating surface 548 square feet. Two of these boilers were used together in the trials, for supplying steam to one main engine, air-pump engine, and feed pump; from the domes, which are 2ft. diameter and 3ft. high, the steam was led through pipes 3in. diameter and 21½ft. long, into a steam main 6in. diameter and 19ft. long, from which a branch 4in. diameter for 68½ft. length and 2½in. diameter for 9½ft. length led to the engine; the surface of the steam pipe was therefore about 141 square feet.

A jacket by which the boiler steam could be partially dried, or possibly slightly superheated, was fitted on the steam branch. It consisted of a 6in. pipe enclosing a length of 51½ft., or a surface of 54 square feet of the branch; the space between the two pipes could be filled at pleasure with steam supplied from the boiler of a small locomotive, which was kept blowing off at 140 lb. pressure. The water condensed in the space between the pipes passed off by a drain-cock from the lowest point. The boilers were lagged with wood and sheet iron, except at the sides of the fire-boxes; the steam pipes were clothed throughout their lengths with strips of roofing felt. The feed pump is of the Worthington pattern, with four rams of 3¼in. diameter and 6in. maximum stroke. The exhaust pipe from the main engine is 4in. diameter and 8⅜ft. long, and was arranged either to exhaust direct into the air, or to be connected at pleasure with the condenser by a pipe 6in. diameter and 13¼ft. long. The air pump and circulating pump were driven at speeds varying from 42 to 54 revolutions per minute, and a vacuum of from 26in. to 28in. of mercury was readily maintained. From 210 to 270 gallons of circulating water passed through the condenser per minute, and the rise of temperature in the water averaged about 15° Fah. The exhaust steam from the engine driving the air and circulating pumps was condensed in a pipe 1½in. diameter and 92ft. long, with a surface of about 36 square feet, which was immersed in cold water; the resulting condensed water was collected and measured, and the quantity was found to range from 0·09 to 0·13 lb. per revolution. The exhaust from the feed pump was similarly condensed in a pipe 1in. diameter and 37ft. long, with about 10 square feet of surface; and it was found that the weight of steam required to drive the feed pump averaged 0·025 lb. per lb. of feed-water pumped. The water of condensation from the main engine passed from the air pump through a pipe 4in. diameter and 54½ft. long, at the end of which it was collected, and was transferred to a rectangular measuring tank holding 47·19 gallons, which when full was emptied into the feed tank.

The total weight of water from the main engines is thus obtained during a trial; and when divided by the number of strokes ascertained from a counter, it gives the weight of water and steam passing through the engine per stroke. It was attempted at first to ascertain the quantity of water used in the non-condensing trials, and also to check the quantity condensed in the other trials, by measuring the total feed-water supplied to the boilers during a trial, after they had been pumped up to the original level in the gauge glasses. There proved, however, to be so much difficulty in ascertaining accurately the amount of water in the boilers when steam was up, and so many minor discrepancies appeared in the condensing trials, in reconciling the amount thus obtained with the quantity condensed, that this method was abandoned. The exhaust steam was therefore passed through the condenser for all the trials, the air-pump suction-pipe being disconnected when it was not desired to make use of the vacuum. The non-condensing trials were therefore really condensing at atmospheric pressure; but the indicator diagrams so taken cannot practically be distinguished from ordinary non-condensing diagrams, while in the author's opinion the weights of water used are much more accurately obtained than by measuring the feed-water. Hartley coal, of about three-quarters the evaporative value of best Welsh steam coal, was used throughout the trials. The average evaporation was about 7·9 lb. of water per lb. of coal; and the rate of combustion varied from about 6·5 lb. to 12·4 lb. per square foot of grate per hour. No priming worth notice appeared at any time.

The series of trials extended altogether over fifty hours' working of the engine; but out of this total various results, representing in the aggregate twenty-eight hours' working, were rejected on account of doubtful measurements as to some point or other. The results of the remaining twenty-two hours' working are believed to be accurate, so far as the measurements and indicator diagrams are concerned, and are given without further selection. These trials are sixteen in number, in two sets, one condensing and one non-condensing, each with and without the steam pipe jacketted, and each with a cut-off at approximately one-quarter and one-eighth and one-sixteenth of the stroke successively, thus making twelve different combinations. The remaining four of the sixteen trials are repetitions of some one or other of these twelve, and were made in order to check the results, and to ascertain the probable limits of difference under varying conditions of weather and slightly varying pressures and speeds. Indicator diagrams were taken at frequent and tolerably regular intervals with a Richards' indicator having a spring of 30 lb. to the inch; the spring was tested by the makers at the conclusion of the trials, and was found to be correct. Six of the trials lasted two hours each, and the remaining ten were one hour each. The number of indicator diagrams taken in any one trial varied from eight to twenty-four, and it was found that, including the shifting of the indicator from either end of the cylinder to the other, one diagram could be taken about every five minutes. The calculated mean of the measured ordinates in each indicator diagram, at every tenth of the stroke including clearance, was taken as the basis of calculation for determining the distribution of heat. The clearance is 7 per cent. of the volume described by the piston; and the real number of expansions corresponding with the nominal cut-off at one-fourth and one-eighth and one-sixteenth of the stroke averaged 3·4 and 5·8 and 6·7 respectively.

The method of calculation is based on one described by Professor Cotterill.[2] It consists in ascertaining, from the weight of water used per stroke, and from the pressure given in the calculated mean diagram at the end of the stroke or at any point after the cut-off, the volume occupied by one pound of the working mixture of steam and water in the cylinder, excluding the cushion steam. Dividing the volume thus found by the volume which would be occupied by one pound of saturated steam at the same pressure, the quotient will be the proportion of steam in the working mixture in the cylinder. The number of thermal units in this weight of steam can then be ascertained from tables of the properties of steam. The number of thermal units contained in the water making up the remainder of the working mixture can be similarly ascertained from tables. The number of thermal units converted into work from the commencement up to any point in the stroke will be that corresponding with the mean pressure from the commencement up to that point of the stroke multiplied by the volume of one pound of the working mixture at that point. These three numbers of thermal units being added together, and their sum subtracted from the total heat in an equal weight of saturated steam at the initial pressure, the difference will be the amount of heat abstracted from the steam by the metal of the cylinder and piston, less re-evaporation, and by other sources of loss up to this point in the stroke. The amount of heat corresponding with the work done in overcoming the back pressure is approximately ascertained by multiplying the average back pressure, as determined from the diagram, by the volume of one pound of the working mixture at the point of the stroke under consideration; and the amount corresponding with the effective work is obtained by deducting the heat corresponding with the back pressure from the total heat converted into work. The amount of heat which would be required per pound of steam for performing the same work in a perfect engine, working between the same limits of temperature, can be readily calculated; and if this is subtracted from the total amount of heat actually received in a pound of initial steam, the difference will give the heat wasted from all causes.

These results are shown graphically in the accompanying diagrams, Figs. 1 to 35; of these we give in Figs. 1 to 4 a typical pair.

Fig. 1 Steam-pipe Jacketed.

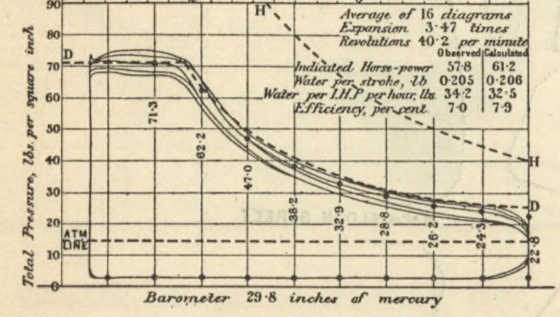
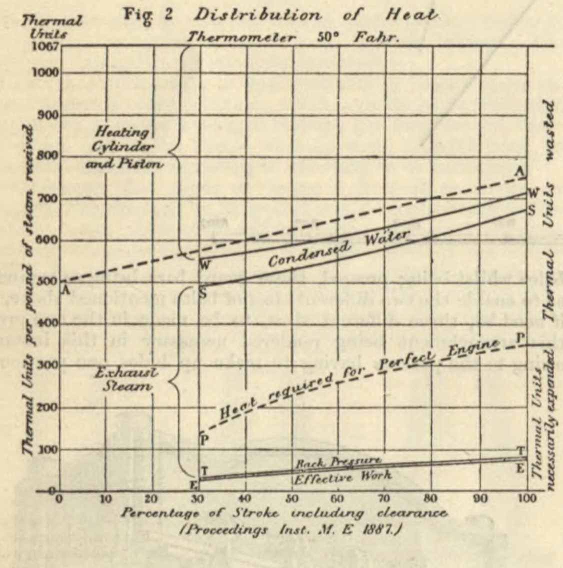


Fig. 2 Distribution of Heat. Thermometer 50° Fahr.



(Proceedings Inst. M. E. 1887.)

Fig. 3 Steam-pipe Jacketed.

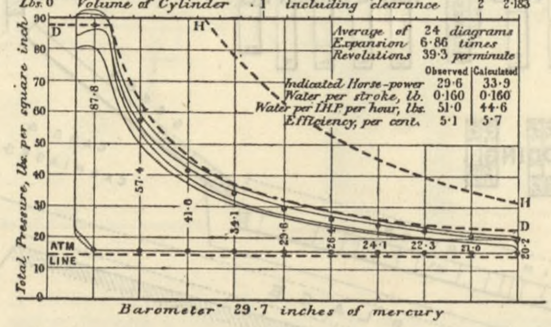
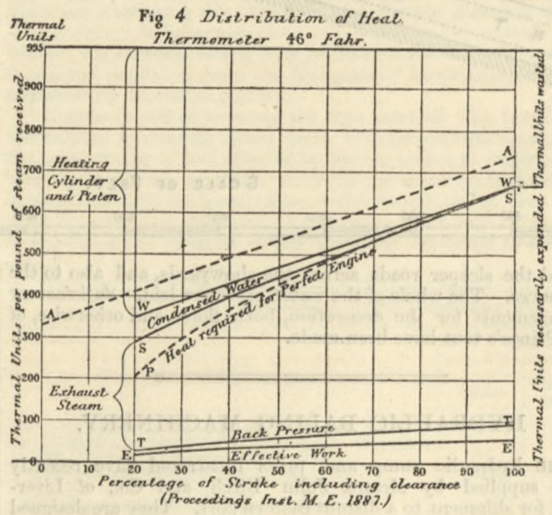
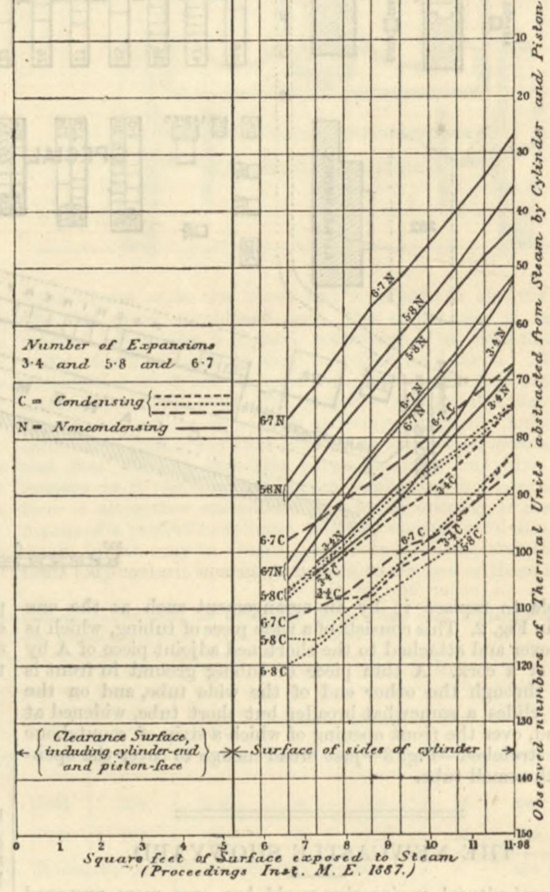


Fig. 4 Distribution of Heat. Thermometer 46° Fahr.



(Proceedings Inst. M. E. 1887.)

Fig. 5 Initial Condensation and Re-evaporation.



(Proceedings Inst. M. E. 1887.)

In the indicator diagrams the lengths of the average ordinates, measured between the zero line and the small circles in the upper curves and also marked in figures, show the pressures taken for calculation; and some of the original indicator diagrams are drawn in, from which these average ordinates were obtained. To avoid confusion only the two extreme indicator diagrams are shown, with a few of the intermediate ones. The abscissæ represent the volumes, including clearance, from the beginning to the end of the stroke, in both the upper and the lower diagrams on each figure. In the lower diagram on each figure, the total height represents the number of thermal units which are contained in 1 lb. of steam at the initial pressure, in excess of the number contained in 1 lb. of water at the temperature corresponding with the back pressure—this latter being the final state in which it may be conceived that each pound of the working mixture is recovered after use, and is returned to the boiler.

The number of thermal units which have been converted into effective work at any point in the stroke, being plotted as ordinates from the base line, give the lowest curved line E E in the diagram. Adding to these the number of thermal units corresponding with the back pressure gives the curve T T of total work performed by one pound of steam. The number of thermal units contained in the weights of steam and condensed water respectively, which together make up one pound of the working mixture, in excess of the number of units contained in the same weights of water at a temperature corresponding with the back pressure, are then successively plotted as ordinates upwards from the curve of total work. By joining the summits of these ordinates, the two highest lines S S and W W on the diagram are formed; and at any point of the stroke the remaining height from the uppermost of these lines W W, up to the top horizontal line which represents the number of thermal units supplied in one pound of steam, will show the amount of heat abstracted by condensation on the surfaces of the cylinder and piston, and by other sources of loss. This amount is gradually diminished by re-evaporation between the cut-off and the end of the stroke, the diminution being nearly in proportion to the increase of volume.

The dotted curve P P on the diagram represents the amount of heat theoretically necessary, or that which would be required per pound of steam in a perfect engine, to perform the total work shown by the curve T T; and therefore the vertical distance between any point in this curve P P, and the top horizontal line representing the number of thermal units supplied at the commencement of the stroke, will give the heat wasted from all causes. The ratio of efficiency, given in figures on each indicator diagram, is obtained by dividing the number of thermal units corresponding with the effective work by the number supplied at the commence-

[1] Institution of Mechanical Engineers.

[2] See "The Steam Engine Considered as a Heat Engine," by James H. Cotterill, 1878, pages 281-2.

ment of the stroke. If the steam supplied is mixed with water carried over by priming, or condensed in the steam pipes, there will be no alteration in the curves representing the distribution of heat, so far as the author can see; for these depend solely on the amount of water mixed with the steam at the end of the admission; and whether this water is derived from condensation during admission, or originally enters the cylinder in the liquid state, will not affect the result. If priming or condensation in the steam pipes exists in a perceptible degree, however, the heat supply per pound of steam and water passing through the engine will be proportionately reduced; and therefore the loss by condensation during admission will be actually less than appears from the diagram. This condensation cannot, however, in any case be less than the subsequent re-evaporation during the remainder of the stroke. It appears to the author to be impracticable to determine, with any approach to accuracy, what the amount of priming or condensation in a steam pipe may be; the ratio of efficiency in each case is therefore calculated on the assumption that the steam supplied is practically dry. It will be seen from the diagrams that the effects of jacketting the steam pipes are small and variable; and in the author's opinion they do not in any case extend beyond the re-evaporation of water condensed in the steam pipes, or possibly a diminution of priming. The absolute efficiency, or ratio of the effective work performed pound weight of steam. The palpable convergence of all these curves to the zero of exposed surface at about 150 thermal units agrees closely with the hypothesis that there is a sudden initial condensation of the entering steam, equivalent, in all the trials with this engine, to the transference of about 150 thermal units, or 28·6 thermal units per square foot of exposed clearance surface, to the surface metal of the steam passages, cylinder, and piston; and that this heat is gradually given back again to the steam during the stroke, by the excess of re-evaporation over further condensation in the cylinder. The heat thus regained by the steam increases approximately in direct proportion to the surface exposed; but still leaves in the metal, at the end of the stroke in this engine, an amount of heat equivalent to 0·4 thermal unit for each degree of difference between the temperatures corresponding with the initial and back pressures.

The adoption of this hypothesis renders it possible to calculate the weight of water required per stroke, and also at any point of the stroke the quantity of heat abstracted by the metal per pound weight of steam supplied. This calculated quantity of heat abstracted is shown by the dotted line A A on the lower diagram for each of the sixteen trials, see p. 16, in comparison with the observed amount shown by the uppermost full line W W. It also becomes possible, by a reversal of the process detailed in the

TABLE I.—*Calculated Efficiency of Engine and Consumption of Water with two different Points of Cut-off and with varying Lengths of Stroke.*

Diameter of cylinder 16in. Clearance 0·143 cubic foot. Clearance surface 5·24 sq. ft.	Point of cut-off 1·4in. Absolute pressures per sq. in.:—Initial, 87·4lb.; back, 2·7lb.			Point of cut-off 4·25in. Absolute pressures per sq. in.:—Initial 71·3lb.; back, 2·9lb.				
Length of stroke .. .. In.	8·0	18·0	21·8	8·0	18·0	21·8	38·6	46·3
Number of expansions	3·47	7·24	8·67	1·68	3·47	4·20	7·24	8·67
Percentage of efficiency .. p.c.	4·8	7·3	8·1	5·3	7·9	8·6	10·3	11·1
Water consumed per I.H.P. per hour .. .. .. Lbs.	56·0	34·6	31·3	54·8	32·5	30·0	23·0	21·0

APPENDIX.

The following are the details of the calculation for determining the distribution of heat at 80 per cent. of the stroke including clearance, in the trial of 18th November, 1886, condensing,

TABLE II.—*Results of Trials.*

1886. November and December. Diagrams shown on p. 16.		Horse-power, speed, and water consumption.												Cylinder pressures: Initial, terminal, mean forward, and mean back.											
		1 Indicated horse-power.			2 Revolutions per minute.			3 Consumption of water. Lbs. per I.H.P. per hour.			4 Lbs. per stroke.			5 Initial. Lbs. per sq. inch.			6 Terminal. Lbs. per sq. inch.			7 Mean forward. Lbs. per sq. inch.			8 Mean back. Lbs. per sq. inch.		
Nominal cut off		1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16
Number of expansions ..		3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7
		I.H.P.	I.H.P.	I.H.P.	Revs.	Revs.	Revs.	Lbs.	Lbs.	Lbs.	Lb.	Lb.	Lb.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Condensing.	Steam pipe jacketted.		50·3			39·5			34·0			0·182			89·0			18·9			39·4			3·2	
		57·8	46·6	46·9	40·2	39·7	40·9	34·2	36·1	34·6	0·205	0·176	0·165	71·3	82·6	87·4	22·8	17·6	17·0	43·1	36·1	35·0	2·9	3·2	2·7
			49·4			40·4			38·2			0·194			83·3			19·3			38·0			4·2	
	Not jacketted.		51·0			40·3			34·7			0·183			86·5			18·7			38·0			2·5	
		62·0		45·7	42·2		41·2	35·4		38·8	0·217		0·179	72·6		86·8	23·5		16·0	44·1		33·5	2·6		2·4
			47·2			40·4			38·9			0·190			83·3			17·7			36·1			3·3	
Non-condensing.	Steam pipe jacketted.			29·6			40·1			42·9			0·132			88·1			20·0			36·8			16·2
		52·4	36·2		40·4	40·1		39·6	41·2		0·214	0·155		83·7	90·9		28·8	22·3		51·8	41·7		15·4	16·5	
				29·6			39·3			51·0			0·160			87·8			20·2			36·6			15·5
	Not jacketted.	51·0	36·0	29·7	39·8	40·3	39·5	41·1	42·6	50·5	0·220	0·158	0·158	87·6	91·6	89·3	28·1	21·9	20·0	52·6	41·8	36·7	16·6	16·7	15·6

TABLE II. (*continued*).

1886. November and December. Diagrams shown on page 16.		Work done per lb. of steam supplied: Total, effective, and back pressure.									Heat lost and heat supplied per pound of steam.											
		9 Total work.* Thermal units per lb. of steam supplied.			10 Effective work. Thermal units per lb. of steam supplied.			11 Back-pressure work. Thermal units per lb. of steam supplied.			12 Thermal units of heat lost at end of stroke. Exhaust steam.			13 Water in cylinder.			14 Abstracted by cylinder.			15 Thermal units of heat supplied.†		
Nominal cut-off		1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16
Number of expansions..		3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7
		Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.	Units.
Condensing.	Steam pipe jacketted.		82			75			7			543			36			407			1068	
		80	78	80	75	71	74	5	7	6	590	526	550	38	35	35	359	427	407	1067	1066	1072
			75			66			9			521			32			427			1055	
	Not jacketted.		79			72			7			544			40			412			1075	
		77		71	72		65	5		5	567		482	43		42	384		482	1071		1077
			72			65			7			489			37			467			1065	
Non-condensing.	Steam pipe jacketted.			107			61			46			684			3			199			993
		92	103		65	63		27	40		613	650		11	5		279	235		995	993	
				87			51			36			571			5			332			995
	Not jacketted.	91	100	88	62	61	51	29	39	37	581	621	573	10	4	5	310	269	330	992	994	996

* The figures in group 9 are severally the sum of the corresponding figures given in the two succeeding groups 10 and 11.
† The figures in group 15 are severally the sum of the corresponding figures given in the four preceding groups, 9, 12, 13, 14.

TABLE II. (*continued*).

1886. November and December. Diagrams shown on p. 16.		Volumes of steam. Condensation in cylinder.									Efficiency of actual engine: Absolute and relative.								
		16 Volume of one pound of steam and water in cylinder at end of stroke.			17 Volume of one pound of saturated steam at terminal pressure.			18 Condensation* in cylinder at end of stroke.			19 Total work of perfect engine. Thermal units per pound of steam supplied.			20 Absolute efficiency† of actual engine at end of stroke in percentage of heat supplied.			21 Relative efficiency‡ of actual engine in percentage of efficiency of perfect engine.		
Nominal cut-off		1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16	1–4	1–8	1–16
Number of expansions		3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7	3·4	5·8	6·7
		Cub. ft.	Cub. ft.	Cub. ft.	Cub. ft.	Cub. ft.	Cub. ft.	Per cent.	Per cent.	Per cent.	Units.	Units.	Units.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Condensing.	Steam pipe jacketted.		11·73			20·83			43·7			240			7·0			31·3	
		10·55	12·13	13·00	17·40	22·25	22·94	39·3	45·5	43·3	244	233	249	7·0	6·7	6·8	30·8	30·5	29·3
			10·98			19·81			45·5			217			6·3			30·5	
	Not jacketted.		11·81			21·13			44·1			252			6·6			28·2	
		9·87		12·03	16·95		24·32	41·9		50·5	237		254	6·7		6·1	30·3		25·6
			11·27			22·13			49·2			233			6·1			28·0	
Non-condensing.	Steam pipe jacketted.			15·12			19·72			23·3			129			6·1			47·2
		9·54	12·96		13·99	17·80		31·8	27·2		129	131		6·5	6·4		49·6	48·1	
				12·50			19·54			36·1			131			5·1			39·0
	Not jacketted.	9·29	12·00	12·64	14·32	18·15	19·72	35·1	30·4	35·9	127	131	134	6·2	6·1	5·1	48·8	45·8	38·1

* The figures in group 18 are severally the percentage of difference between the corresponding figures given in the two preceding groups 16 and 17.
† The figures in group 20 are severally the quotient resulting from the division of those in group 10 by those in group 15.
‡ The figures in group 21 are severally the quotient resulting from the division of those in group 10 by those in group 19.

to the heat supplied, is approximately, but not by any means exactly, in inverse proportion to the weight of water consumed per indicated horse-power per hour. The difference depends principally on the varying limits of temperature between which the engine is worked and the consequently varying amount of heat supplied per pound of steam.

In the appendix are shown the detailed figures worked out for determining in one of the trials the heat distribution at 80 per cent. of the stroke. The calculations required at any other point are precisely similar to these. In Table 2 are collected the results of the whole series of trials, worked out for the termination of the stroke. In the somewhat laborious calculations involved in obtaining these results, the author has received much valuable assistance from Captain Willock, R.E.

A comparison of the whole of the observed results is shown in the diagram, Fig. 5, in which the abscissæ represents square feet of surface exposed to the steam throughout the stroke by the steam passage, cylinder, and piston; the clearance surface measures 5·24 square feet at the commencement, and the total surface 11·98 square feet at the end of the stroke. Ordinates measured downwards from the top of the diagram represent the number of thermal units abstracted from the enclosed steam at any point; and the curves shown are plotted from such ordinates, obtained for each point of the stroke by multiplying the observed weight of steam and water in the cylinder in each case by the number of thermal units already ascertained to have been abstracted from one appendix, to calculate approximately the indicator diagrams resulting from the assumed distribution of heat; and these are shown in each case by the dotted lines D D, Figs. 1 and 3, for comparison with the actual diagrams drawn by the engine. The corresponding calculated horse-power, weight of water per stroke, weight of water per horse-power per hour at the observed number of revolutions, and the calculated ratio of efficiency, are marked in figures on the indicator diagrams. The dotted curve H H on each diagram shows the hyperbolic expansion curve corresponding with the observed weight of saturated steam per stroke.

The conclusions drawn by the author are:—that, in order to obtain the best results for any given range of temperature, there should be a definite relation between the surface of the steam passages, the diameter of the cylinder, and the length of stroke; and that in the design of a steam engine the adjustment of these proportions is perhaps the most important point to be considered as regards economy. The following Table I shows, for two different points of cut-off, the calculated results of varying the length of stroke of the engine which was experimented on, while the diameter of the cylinder, the absolute clearance volume, and the clearance surface exposed, remain unaltered; and it will be seen that the same number of expansions may give widely different results as regards the ratio of efficiency and the water consumed per indicated horse-power per hour; and also that, with the same length of stroke, these results are but slightly affected by doubling the number of expansions.

cutting-off at one-sixteenth of the stroke, and with the steam pipe jacketted.

Total water used during trial, 1623 lb.

Number of revolutions during trial, 2455.

$$W = \text{water per stroke} = \frac{1623}{4 \times 2455} = 0{\cdot}1653 \text{ lb.}$$

Clearance, 7 per cent. of stroke.

Average point of compression, 96·68 per cent. of return stroke.

Mean absolute pressure at commencement of compression = 2·32 lb. per square inch.

p_c = mean absolute cushion-pressure at commencement of stroke $= 2{\cdot}32 \times \frac{3{\cdot}32 + 7}{7} = 3{\cdot}4$ lb. per square inch.

p_1 = initial pressure = 87·4 lb. per square inch.

p_b = back pressure = 2·7 lb. per square inch.

p_2 = terminal pressure at 80 per cent. of stroke including clearance = 19·3 lb. per square inch.

p_m = mean pressure from commencement to 80 per cent. of stroke including clearance = 39·5 lb. per square inch.

Total volume to end of stroke including clearance = 2·183 cubic feet.

Total volume swept through from commencement to end of stroke = 2·040 cubic feet.

Total clearance volume = 2·183 − 2·040 = 0·143 cubic foot.

A = volume swept through from commencement to 80 per cent. of stroke including clearance = 2·040 − 0·2 × 2·183 = 1·603 cubic foot.

= ratio of clearance volume to $X = \frac{0·143}{1·603} = 0·089$.

Total volume to 80 per cent. of stroke including clearance = $(1 + c)\,X = 1·089 \times 1·603 = 1·746$ cubic foot.

Ratio of clearance to total volume at 80 per cent. of stroke, including clearance $= \frac{c}{1 + c} = \frac{0·089}{1·089} = 0·082$

n = volume of cushion steam at terminal pressure, in decimals of total volume $= \frac{c}{1 + c} \times \frac{p_c}{p_2} = 0·082 \times \frac{3·4}{19·3} = 0·0144$.

Volume of working steam at terminal pressure, in decimals of total volume $= 1 - n = 0·9856$.

Volume of working steam at terminal pressure, in decimals of space swept through $= (1 - n)\,(1 + c) = 0·9856 \times 1·089 = 1·073$.

Volume of working steam in cubic feet $= (1 - n)\,(1 + c)\,X = 1·073 \times 1·603 = 1·72$ cubic foot.

V = volume of one pound of working mixture $= \frac{(1 - n)\,(1 + c)\,X}{W}$

$= \frac{1·72}{0·1653} = 10·41$ cubic feet.

v = volume of 1 lb. of saturated steam, at terminal pressure p_2 of 19·3 lb. = 20·4 cubic feet.

s = volume of 1 lb. of water = 0·016 cubic foot.

If x is the fraction by weight of saturated steam in the working mixture of steam and water, then $x\,v + (1 - x)\,s = V$; therefore $x = \frac{V - s}{v - s} = \frac{10·41 - 0·016}{20·4 - 0·016} = \frac{10·394}{20·384} = 0·51$

Fraction by weight of water in working mixture $= 1 - x = 0·49$.

p' = mean pressure reduced to correspond with working volume, by deducting pressure due to clearance steam $= \frac{p_m}{(1+c)\,(1-n)}$

$= \frac{39·5}{1·073} = 37$ lb. per square inch.

E_2 = total work in thermal units $= \frac{p'_m \times V \times 144}{772} = \frac{37 \times 10·41 \times 144}{772}$

= 72 thermal units.

E_b = back-pressure work in thermal units $= \frac{p_b \times V \times 144}{772}$

$= \frac{2·7 \times 10·41 \times 144}{772} = 5$ thermal units.

Effective work in thermal units $= E_2 - E_b = 72 - 5 = 67$ thermal units.

I_2 = thermal units in raising 1 lb. of water from freezing point and evaporating it at the terminal pressure p_2 of 19·3 lb. per square inch, or temperature t_2 of 226 deg. = 1077 thermal units.

h_b = thermal units in raising 1 lb. of water from freezing point to temperature t_b of 137 deg., corresponding with back pressure p_b of 2·7 lb. per square inch = 106 thermal units.

Thermal units in raising the weight of steam in 1 lb. of the working mixture from temperature t_b of 137 deg., and evaporating it at pressure p_2 of 19·3 lb. per square inch $= (I_2 - h^b)\,x = (1077 - 106) \times 0·51 = 495$ thermal units.

h_2 = thermal units in raising one pound of water from freezing point to temperature t_2 of 226 deg., corresponding with terminal pressure p_2 of 19·3 lb. per square inch = 195 thermal units.

Thermal units in raising the weight of water contained in one pound of the working mixture from temperature t_b of 137 deg. of back pressure to temperature t_2 of 226 deg. of terminal pressure $= (h_2 - h_b)\,(1 - x) = (195 - 106) \times 0·49 = 44$ thermal units.

Q_1 = thermal units supplied per pound weight of steam at temperature t_1 of 318 deg. and initial pressure p_1 of 87·4 lb. per square inch = 1178·5 − 106 = 1072·5 thermal units.

Thermal units abstracted by cylinder, per pound weight of steam $= Q_1 - E_2 - (I_2 - h_b)\,x - (h_2 - h_b)\,(1 - x) = 1072·5 - 72 - 495 - 44 = 461·5$ thermal units.

Ratio of efficiency of a perfect engine $= \frac{t_1 - t_b}{t_1 + 461°} = \frac{318° - 137°}{318° + 461°}$

$= 0·2324$.

E_1 = thermal units convertible into work in a perfect engine per pound weight of steam $= Q_1 \times \frac{t_1 - t_b}{t_1 + 461°} = 1072·5 \times 0·2324$

= 249 thermal units.

Ratio of necessarily rejected heat of actual work $= \frac{Q_1 - E_1}{E_1} = \frac{t_b + 461°}{t_1 - t_b}$

$= \frac{598}{181} = 3·3$.

Total necessary heat in actual engine per pound weight of steam $= \left(1 + \frac{Q_1 - E_1}{E_1}\right) E_2 = 4·3 \times 72 = 310$ thermal units.

Heat wasted per pound weight of steam = 1072·5 − 310 = 762·5 thermal units.

Absolute ratio of efficiency of actual engine at 80 per cent. of stroke including clearance $= \frac{E_2 - E_b}{Q_1} = \frac{67}{1072·5} = 0·0625$.

Relative efficiency of actual engine compared with perfect engine at 80 per cent. of stroke including clearance $= \frac{E_2 - E_b}{E_1} = \frac{67}{249} = 0·269$.

The results of the precisely similar calculations worked out for the termination of the stroke, and for the whole series of the trials, are collected in the accompanying Table II, pages 16-21.

LETTERS TO THE EDITOR.

(*Continued from page* 4.)

THEORETIC DIAGRAMS.

SIR,—In my last letter I confined myself to the relative placing of the several figures in a combined diagram, as I had not the volume of "Proceedings" of the Institution of Mechanical Engineers by me, and I wished to re-peruse Mr. Mudd's remarks on Mr. Wyllie's paper together with his letter, before saying anything as to the standard diagram or the theoretical expansion curves for the several cylinders. In Fig. 4, on page 111 of your present volume there is no vertical line to show where the standard diagram ends, or that the low-pressure diagram extends beyond it. This led to my mistaken impression that Mr. Mudd's method did not give the correct theoretical area for comparison with the actual ones. Also, in the description of the same figure it was stated that D E is a curve due to steam D K, and further on, that E G is again a new curve due to steam D E—query misprint for L E?

This very naturally led me to say that the diagram did not give the correct theoretical expansion curves for the several cylinders, for D E and E G should be curves due to volumes of steam larger than D K and L E respectively, viz., to volumes including the whole clearance of the cylinders. This has been made clear by Mr Mudd in that part of his letter referring to Fig. 57, plate 3, of the "Proceedings" of the Institution of Mechanical Engineers for February, and this correction, together with the full report of Mr. Mudd's remarks in that volume, which I had not had a chance of seeing when I wrote my paper, show that he and Mr. Schönheyder are practically agreed, for, as Mr. Mudd says, the placing of the standard diagram is immaterial, and it would be clearer to keep it quite distinct from that showing the action of the steam; in which case, the actual figures might be placed in any way that would bring them all within it.

I think, Sir, it would be a great advantage to your readers if you would reproduce the Fig. 57 alluded to, together with that portion of Mr. Mudd's remarks describing it. With regard to this standard diagram, it has struck me that the net volume of low-pressure cylinder, *i.e.*, exclusive of clearance, is not the correct one to take. I think that the correct standard to take would be the area obtained by expanding, without loss, the volume of steam admitted to the high-pressure cylinder at initial pressure, to the same volume it expands to in the case under examination. This volume might be either greater or less than the net volume of low-pressure cylinder. This could be best shown by a diagram, but I shall endeavour to make myself clear in another way. Suppose that we have a set of diagrams from a triple expansion engine working with an absolute initial pressure in high-pressure cylinder of 160 lb., and having a low-pressure cylinder, 44ft. cubic feet capacity with 4 cubic feet of clearance, or a total capacity of 48 cubic feet.

Next, suppose we find from our diagrams that the volume of steam admitted to the high-pressure cylinder at initial pressure = 4 cubic feet, and that in the low-pressure cylinder the back pressure is increased by compression to 10 lb. at the end of the stroke, then we have 4 cubic feet at 10 lb. in the low-pressure clearance; and if in this case we assume, for simplicity of calculation, that the expansion and compression follow the hyperbolic curve, this will equal $\frac{1}{4}$ cubic foot at 160 lb. Add to this the 4 cubic feet at 160 lb. admitted to the engines, then we have $4\frac{1}{4}$ cubic feet at 160 lb. to expand out to 48 cubic feet. As the two parts of which this volume is made up expand together, the space finally occupied by the 4 cubic feet admitted will be $\frac{16}{17}$ of 48 = 45·176 cubic feet, or more than the net volume of low-pressure cylinder by 1·176ft.

Again, if we had found from our diagrams that the steam behind low-pressure piston was compressed up to 20 lb. instead of 10 lb., this = $\frac{1}{2}$ cubic foot at 160 lb. So that we should have $4\frac{1}{2}$ cubic feet to expand to 48, and in this case the final volume of the steam used would be $\frac{8}{9} \times 48 = 42·66$ cubic feet, or less than the net volume of low-pressure cylinder. In these two cases it is evident that the total ratio of expansion is different, whereas if we took the net volume of the low-pressure cylinder, we should have had the same standard diagram for both.

On this principle, in order to find the length of the standard diagram, it is only necessary—(1) To find from the diagrams the equivalent volume of steam at initial pressure admitted to high-pressure cylinder; call this (a). (2) To find from low-pressure compression corner the equivalent volume of steam, at same pressure as above, shut up in low-pressure clearance; call this (b). (3) Set off on a base line the total volume of low-pressure cylinder—including clearance—and divide it into two parts bearing the same proportion to each other that (a) bears to (b). The greater of these parts will be the length required. This standard diagram gives the maximum work that can be obtained from the steam used in the actual engine expanded the same number of times as in that engine.

Again, if we were to make the length of standard diagram equal the total volume of low-pressure cylinder, we should use for our standard of comparison the maximum amount of work that could be got by expanding the same steam into the same low-pressure cylinder as in the actual engine under perfect conditions, viz., against a perfect vacuum, and some people might prefer this form.

There is another point I should like to draw attention to in regard to these diagrams, and that is, the point through which the theoretical curve for the high-pressure diagram is drawn. Sometimes it is drawn through a point just after the cut-off and sometimes just before the release. The first is generally sure to be wrong, as it takes no account of the steam condensed on entering the cylinder, and therefore does not represent the whole of the steam admitted to the engines. The second is not certain to be right, as all the water of initial condensation may not be re-evaporated before the end of the stroke. In an old correspondence in *Engineering* sixteen years ago, Mr. Macfarlane Gray very rightly said, referring to ordinary double expansion compounds: Measure both diagrams and find the point in either of them which shows the greatest quantity of steam—*i.e.*, the greatest product of volume and pressure—and take that as the nearest approach to the quantity of steam used that we can obtain from the diagrams.

In Mr. Mudd's properly combined diagram of the Abeona, Fig. 57, already referred to, it will be noticed that the expansion line of the intermediate cylinder rises above the theoretical curve for that cylinder, which would point to the conclusion that that curve is incorrect in some way. This might arise either from the steam in the second cylinder expanding on a different law from that in the first, while all the theoretical curves are taken as adiabatic, I believe; or from the fact that the high-pressure curve being drawn tangent to the diagram, does not account for all the steam admitted. I am inclined to think the latter is the case, and that it would have been better to take a point just before release in the second diagram as the starting point for all the curves, and work both ways, first drawing the theoretical curves for the three diagrams, and then from the top of the high-pressure one, starting the curve for the standard diagram in the way Mr. Mudd prefers. I think the probability is that even then we should not arrive at a true estimate of the steam admitted to the engine, as there is very likely some of the water of initial condensation which never reappears on the cards at all. J. JENNINGS CAMPBELL.

Liverpool, June 29th.

DOMESTIC DRAINAGE.

SIR,—By your permission I will reply very briefly to Mr. William Dodds' letter in THE ENGINEER of June 24th. I have carefully looked through my former letter, and fail to find any statement such as Mr. Dodds discovers, that one firm—the North British Plumbing Company—had introduced iron drainage entirely, and this only. I may as well state at once that I have not, and have never had any direct interest in that company, as Mr. Dodds would seem to infer, and that it is several months since I rendered them any professional services whatever. I may add that my having done so in the past was precisely the reason why—save by a single casual allusion, which, but for Mr. Dodds' letter, would probably have passed unnoticed—I did not refer, as I should have liked to do, to the excellent work in house sanitation developed and carried out by that firm.

As regards the houses on the Kensington-court estate, I beg to refer Mr. Dodds to the *Architect* for May 6th, page 262, from which I extracted my statement. No doubt the work—with which I had nothing whatever to do, either then or since—was first-rate of its kind, and I do not suppose Mr. J. J. Stevenson would be satisfied with anything less; but I still hold that the more complete development of the system of cast iron drainage and the employment of that material throughout wherever possible, and especially for manholes, is a distinct advance upon the older system. If Mr. Dodds would point out its remaining defects, if any, and suggest how to amend them, it would be more to the point than the element of personal feeling which he has unfortunately endeavoured to import into the question. W. SILVER HALL.

39, Hartington-street, Derby, June 27th.

DURING April the United States exported 955,260 barrels of flour, against 703,128 barrels in the corresponding month last year; and for the ten months ended April 30th the figures are 9,687,702 barrels, against 6,389,835 barrels last year. Of wheat and flour combined the exports in these ten months were 15,422,000 qrs., against 8,611,560 qrs. last year, showing therefore an increase of about 90 per cent.

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

(*From our own Correspondent.*)

ON 'Change in Wolverhampton yesterday and in Birmingham to-day—Thursday—business, both in crude and finished iron, took an unexpected turn for the better, a circumstance which is even more gratifying than at the first blush it would appear. The advent of the end of the half-year and of the stock-taking season is generally accompanied with a more or less laxity of business. The change is therefore all the more welcome, especially when consideration is had to the invariable impetus which is given to trade by the completion of stock-taking. Sellers must derive benefit from the low stocks which will then be shown.

Crude iron exhibits healthier tendencies, both in respect to the extent of business, and in the prices which are being received. This seems to be the effect of the threatened curtailment of supplies from Northampton. Where large parcels are required, consumers generally have thought it inexpedient to postpone operations. Such business, however, is comparatively rare, and the orders are not accepted with so much readiness as formerly, makers believing that the present upward turn in prices will become permanent. For small lots for early delivery there is an inclination to do business.

Better prices are being demanded this week for imported Midland pigs, which have been rendered conspicuously stronger by the blowing off of one or two furnaces. The advance is from 1s. to 1s. 6d. per ton. Lincolnshires were quoted to-day 40s., delivered to stations; Derbyshires, 37s.; Leicestershires, 38s.; and Northamptons, 36s. Prices for special brands were likewise upheld. Staffordshire pigs were firm at 50s. to 52s. 6d. for all-mines, 40s. for part-mines, and 28s. 6d. to 30s. for common.

A brisker inquiry is being received for black sheets, and merchants and consumers are pressing for deliveries. Most of the orders are individually small. Prices are firm. It is doubtful, however, whether any material advance can be made. The appearance of any considerable advance would be followed by the restarting of those works which are now lying idle. Sheets were priced to-day at £5 15s. for merchant singles, £5 17s. 6d. for galvanising ditto, £6 for doubles, and £7 for lattens.

Quotations for galvanised corrugated sheets were £9 15s., f.o.b. Liverpool, for ordinary qualities, but actual prices are believed to be in some cases from 7s. 6d. to 5s. less.

The sheet makers generally have orders on their books which they have been unable to execute through the frequency of the holidays, and the interference which has been occasioned to operations at the mills and forges by the prevailing excessive temperature. Some forward work is therefore provided, and prices have a tendency to more strength on account of the stronger position of pigs.

In the bar trade the interval which will elapse between now and the quarterly meetings, to be held on July 13th and 14th in Wolverhampton and Birmingham respectively, is not expected to be productive of very much good. The prices which now rule are, it is very interesting to note, practically the same as those which prevailed a twelvemonth ago. Marked bars were then £7, with an extra 12s. 6d. for the Earl of Dudley's make; second branded qualities were £6; common bars, £4 15s. to £5; common hoops, £5 5s.; and gas tube strip, £4 17s. 6d. to £5. Sheets were £5 15s., and in some cases £5 10s. for singles, £6 for doubles, and about £7 for lattens. Tank plates were £7, and boiler plates something under £8 for ordinary qualities.

The rates which have ruled for the past six months will not, it is anticipated, be materially changed at the quarterly meetings. The standard for marked bars will remain at £7, and the Earl of Dudley's prices as given last week will be re-declared. Medium and common iron is likely to be somewhat stiffer.

Best bars remain in average request, which is not saying much, but medium and common qualities are limited. Australia is improving slowly, but more orders are being received from South America. There are likewise better indications in some of the other markets.

Steel is particularly healthy, and orders for sheets and plates are especially plentiful. A good demand is being experienced for bars, and the increased appreciation which is being shown for this class of fully manufactured steel is having the effect of advancing the prices of blooms and billets. This is the result of the indifference which makers are showing to book orders for the partially manufactured metal. Blooms and billets imported from Wales, Sheffield, and other districts were quoted on 'Change in Birmingham to-day £4 10s. to £4 15s. for Bessemer qualities, and tin bars £5 for Bessemer and £5 7s. 6d. for Siemens. These rates have been confirmed by the Tin Bar Association for the ensuing quarter. Bessemer plating bars of Sheffield make are quoted £4 15s. to £5 5s., and best Sheffield billets £5 to £6 10s., according to mixture. Welsh steel sheets of 16 to 17 w.g., annealed qualities, were quoted £6 10s. to £7 10s. f.o.b. Liverpool—a price at which Canadian business has during the past few days been done.

The introduction into this district, which I lately recorded, of specimens of the new "fibrous steel," manufactured by Messrs. Dorman, Long, and Co., and Mr. R. Howson, of Middlesbrough, has occasioned inquiries to be made by local steel firms into the possibilities of the new process. I am this week informed that so satisfactory is the result of these inquiries that some local firms are considering the advisability of entering upon the new manufacture under royalty from the patentees.

Nothing is at present being done in this district regarding the intimation which some time ago the ironmasters gave to the men, that they should probably require a reduction on the "extras" now paid for performing certain classes of work in the mills and forges. The masters and men have each appointed representatives to meet and discuss the question together, but no joint meeting has yet been held. Directly after the matter was last up for discussion trade began to improve, and the masters allowed the affair to slide. If, however, demand should not improve, it cannot but be that the men will be called upon to face some definite action. South Staffordshire cannot afford to be unfairly handicapped in the race for orders with newer ironmaking districts.

In commenting upon the report of the Pelsall Coal and Iron Company, the chairman of directors—Mr. G. W. Hastings, M.P.—remarked, at the annual meeting a day or two ago, that, considering the price to which iron had fallen and the small price coal had realised, he did not consider the result altogether unsatisfactory. He for one confidently anticipated that the bad times were in some degree beginning to pass away. Mr. Hastings encouraged the shareholders to look forward to a considerably better year.

The newly formed Bloxwich Steel and Iron Company has purchased the goodwill and trade-marks of the business lately carried on by the Birchills Hall Company, and has also acquired the sole right to manufacture the patent close-joint bedstead tubes as manufactured by that firm. It will carry on the business at the same works at the Birchills, Walsall.

Among the Indian contracts this week upon the market are for a supply of cast iron chairs and of carriage and wagon ironwork for the Indian State railways.

Messrs. James Archdale and Co., of Birmingham, have just produced for Messrs. Kynoch and Co. a cartridge-drawing machine of special construction and unusual magnitude. It weighs nearly twenty-five tons, and is driven with 6in. belts on 5ft. pulleys, the power secured being equal to a pressure of 150 tons. Its novel feature is contained in the provision of two screws, of which one works on each side of a sliding saddle. These are not necessarily in operation together, but the addition of the extra screw is to obviate all side strain upon the framework.

The master engineers of Bolton do not seem likely to get much help from Birmingham, however much they may deserve. Twenty Birmingham operative engineers who went to Bolton on Monday to fulfil an engagement have returned. They allege that they were engaged under a representation that the strike at Bolton was settled; but on reaching there the situation was explained to them by the strike hands, who paid their fares back to Birmingham.

The Cradley Heath chainmakers, finding that they are unable to achieve the object of their strike by adopting pacific measures, are now resorting to outrages to which the district has been a stranger for twenty years. Three workshops of "outworkers" at Dudley, whose occupants have been working below the list demanded, were early on Monday morning simultaneously blown up. Canisters of gunpowder were let down the chimneys, with fuses of sufficient length attached to allow of the perpetrators of the outrages to escape. The roofs were blown off, and the walls were so damaged that the shops will have to be wholly rebuilt. Fortunately, no one was at work in the buildings at the time.

Engineers and machinists in Birmingham are showing interest in the proposal to extend the business of Webster's Patent Aluminium Crown Metal Company, which is being carried on here, by the securing of the patent rights to manufacture sodium under the new process of the young American chemist, Mr. H. Y. Castner, whose operations in Lambeth have proved so great a success. A new company is being formed for the working of the combined Webster and Castner patents. The supplying of the market with aluminium at 20s. per pound, as is promised under Mr. Castner's method, as against 60s., to day's price, must result in a largely increased employment of this most valuable alloy by the local engineering trades.

At a special court held at the Mines Drainage offices, Wolverhampton, on Tuesday, two objections against the draft award of a rate to be levied on the minerals raised from the Tipton mines during the ensuing year were heard. Messrs. Monsell and Davies, of Bradley, applied for a graduation on the ground that they had, at a cost of nearly £1000, driven a private level connecting three mines with the commissioners' level, and Messrs. Addenbrooke and Co., who had been graduated at two-thirds, required a further reduction, their plea being that they had, at great expense, pumped water from their own mines and from the mines of other owners who had been awarded the same graduation. The court withheld their decision.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—"Flat, stale, and unprofitable," is the suggestively descriptive phrase which one now hears very frequently applied to the present condition of trade, and the second quarter of the year just closed has certainly brought forward only a slow and very unsatisfactory business. The past month has of course been so much broken into by the holidays that it has scarcely afforded a fair index of the actual condition of trade, but after every allowance is made the fact is only too evident that there is still an absence of any improvement that could place business and manufacturing operations upon a sound and healthy basis.

The iron market at Manchester on Tuesday was only moderately attended, and it was exceptional where business of any weight was reported. The downward tendency reported from Glasgow and Middlesbrough had a weakening effect upon the market, and prices, although not quotably lower, were, if anything, rather easier. For pig iron there is still only a very limited inquiry, and where business is done it has to be at very low figures. Lancashire makers still quote about 38s. 6d. to 39s., less 2½, for forge and foundry qualities, delivered equal to Manchester; these prices, however, are little more than nominal, as they are altogether impracticable in the open market, but they represent about the basis upon which business is done where local makers have a considerable advantage in the rate of carriage to their customers, and occasional sales of this description form practically the chief business they are at present doing. Local makers would be prepared to meet outside buyers with some concession if they could effect sales, but they do not seem disposed to come down to the prices at which some of the district brands could be bought, and in the open market they are completely undersold by Lincolnshire iron, which can be readily bought at 36s. to 37s., less 2½, for forge and foundry qualities, delivered equal to Manchester. In outside brands offering here, there is, perhaps, in some cases rather more disposition to entertain offers, as the result of the giving way in Glasgow and North of England warrants, but makers' prices do not seem to be appreciably affected. Scotch makers still hold out for the slight advance they recently put upon their prices, and good named foundry brands of Middlesbrough remain firm at 43s. 4d. net cash, delivered equal to Manchester.

A firm tone is maintained in hematites, and for good No. 3 foundry qualities, delivered equal to Manchester, about 53s., less 2½, remains the current market price. One large consumer was reported to have bought pretty freely at Manchester on Tuesday, but the actual price paid did not transpire.

For manufactured iron the demand continues extremely slow, with prices if anything weaker. Delivered into the Manchester district, bars can now be bought at £4 15s. to £4 17s. 6d. per ton; hoops, £5 2s. 6d. to £5 5s.; and local made sheets at £6 5s, with good Staffordshire makes quoted at £6 10s. per ton delivered here.

With regard to the condition of the engineering trades, reports from some quarters continue more hopeful in tone, and the returns of the trades union organisations still show, apart from the men out on strike at Bolton, a steady decrease in the number of members on the books in receipt of out-of-work support, which is certainly evidence of some increased activity. There is, however, still no sufficient improvement in trade to make itself appreciably felt generally, and it is the exception, rather than the rule, where works are more than very indifferently employed, whilst any new work that is to be got continues, in most cases, to be competed for at prices that are so excessively low that they are of themselves an indication of the very poor condition of trade generally.

The bitter feeling which I pointed out was being developed on the part of the men in connection with the Bolton strike is becoming intensified to an extent which may possibly lead to serious results, and certainly precludes the probability of any early settlement of the dispute. The trades union organisations recognise fully the fact that the struggle having been once entered upon, it involves issues which cannot be confined to Bolton, and they are apparently determined to fight it out with all the resources they can command. Both the Amalgamated Society of Engineers and the Steam Engine Makers' Society have decided to call for a special levy to support the men on strike, and voluntary contributions for the same purpose are still coming in freely from other quarters. There is consequently no present lack of funds for carrying on the strike, but the violent action, which has recently been much too frequent, against the men whom the employers are engaging to take the place of those out on strike, and, in fact, against any one who is supposed to be acting in the interests of the employers, can only in the end alienate public sympathy. So far as the employers are concerned, they do not move at all from the position they have taken up, and are gradually filling their works with men obtained from other districts, one large firm having this week brought over 100 men from Scotland.

The other day I had an opportunity of inspecting at Ashton-under-Lyne some improvements in the construction of steam engines and valve gear that have been introduced by Mr. R. Ogden, engineer of the above town, and which are applicable to existing engines. One of these is an improvement in the construction of the cylinders, the object of which is to obviate the unequal expansion and contraction to which the cylinders of steam engines are liable, and this is effected by making the steam cylinder itself in the form of a simple pipe open at each end, without any steam passages or ports, so that an equal thickness of metal is secured all round, and this inner barrel is provided with an outer casing, which forms a steam jacket. The cylinder ends or covers are constructed so as to contain the valve boxes, valves, seatings, steam ports, and exhaust passages; by this means a very short port or passage is obtained between the valves and the cylinder, and almost the full boiler pressure is thus got to act upon the piston. This form of construction is applicable to slide or other valves, but the Corliss type is preferred, and in this an improvement has also been introduced by which it is enabled to act as a cut-off valve as well as a steam admission valve. This improvement consists principally in making the Corliss valve in a compound form composed of an internal valve working inside an outer shell, which latter works in the valve seating. The internal valve can be used as a steam admission valve, and the outer shell as the cut-off valve or *vice versâ* as required. The main valve can be worked by an excentric and the cut-off valve by either cam, tappet, excentric, crank, or other convenient means, and always put forward and backward by the governor, thereby regulating the grade of the cut-off to the load on the engine. This improved form of construction has given very satisfactory results wherever it has been introduced, especially in economising the consumption of fuel, whilst the arrangement for governing the engine is simple and effective.

The cause of the disastrous explosion which occurred last week at the chemical works of Messrs. Roberts, Dale, and Co., of Manchester, is surrounded with extraordinary mystery. The explosion not only wrecked completely the whole of the works, but spread destruction to other property over a very wide area, and the shock of the explosion was distinctly felt for miles distant. Messrs. Roberts, Dale, and Co. emphatically disclaim the use or manufacture at their works of nitro-glycerine, or any other substance which they believe to be an explosive, and are wholly unable to account for the explosion. Until Colonel Majendie, who has inspected the scene of the explosion, has made his report, it would be unwise to give credence to the many suggestions which have been put forward as to the cause; but in the meantime, the apparent possibility of an explosion so disastrous and widespread in its effects occurring at a chemical works in which no known explosive substances were being manufactured, has given rise to a very uneasy feeling in the public mind.

The demand for all descriptions of fuel is extremely quiet, and with pits barely working an average of four days a week stocks are accumulating. It is not only that house-fire coals are hanging in the market as the natural result of the season of the year, but the lower qualities of round coal for steam and forge purposes and engine classes of fuel are all in very poor demand. The current quoted rates remain unchanged, but with stocks accumulating which colliery proprietors are anxious to move, buyers are able to place orders at under list rates, and for clearance sales very low figures are taken. Prices at the pit mouth average 8s. to 8s. 6d. for best coals, 6s. 6d. to 7s. seconds, 5s. to 5s. 6d. common, 4s. 6d. to 4s. 9d. burgy, 3s. 6d. to 3s. 9d. good qualities of slack, and 2s. 6d. to 3s. per ton for common sorts.

The shipping trade is dull, with good qualities of steam coal delivered at the high level, Liverpool, or the Garston Docks not averaging more than 6s. 9d. to 7s. per ton, and a little under these figures taken in some cases.

Barrow.—The hematite pig iron trade is firmer this week, and more business has been done in both Bessemer and ordinary hematite samples. The inquiry has strengthened from the Continent and the Colonies, as well as on home account; but no change can be noted on American account. It is impossible to sell much pig iron to American consumers with the present high tariffs. There is an improvement to note in prices, and an advance of 6d. per ton must be noted alike in Bessemer and ordinary hematite descriptions. Mixed parcels of Bessemer pig iron are quoted at 45s. 6d. per ton net f.o.b.; forge and foundry, No. 3, at 44s. 6d.; and white and mottled descriptions at 43s. 6d. per ton net. There has been a good sale of pig iron at about 43s. 8d. to 44s. 6d. per ton, and makers could sell further large parcels at about these figures. It is probable that some good business will be done in pig iron during the ensuing few weeks. Makers are busy and have work in hand which will maintain activity during the summer and autumn months, while the winter outlook is very cheerful. Stocks of iron, though comparatively large, are not increasing, and it is noteworthy that deliveries are very considerable just now, both on home and foreign account. There is a very full rate of production, and a large proportion of the furnaces remain in blast. Spiegeleisen is being produced by one furnace at Barrow, as the amount now used by steel makers is very large. In the steel trade there is nothing new to report, except that the improvement which set in a few weeks ago has been further accentuated. There is a great demand for steel rails, particularly for heavy sections, which are quoted at £4 3s. per ton net, f.o.b. Other classes of steel are also in better request, and there are prospects of a better trade in blooms, billets, bars, plates, angles, and general steel shipbuilding material. Steel wire and hoops are only an average trade. There is not much doing in steel casting. Forge steel is a quiet trade. The finished iron industry is exceptionally quiet, and no new life is expected, because every day sees an increased use of steel for all the purposes in which finished iron was and is used. In the shipbuilding trade, the revival which was expected has not yet shown itself, but there is no reason to doubt that the year will close with a much more active business in this department than has been experienced from January up to the present time. It is probable that some heavy contracts will come to Barrow builders shortly. There is a better trade in marine engineering, but the general branch of engineering is quiet, and ironfounders and boilermakers are not doing much trade. In the iron ore trade there is again a better feeling, and more business is being done. This is on account of some old contracts running out, and the necessity of renewing them. The consumption of iron ore is very large, and a very small amount of foreign ore is now smelted in the district. Prices vary from 8s. 6d. to 11s. per ton net at mines. There is a steady trade and a full inquiry for coal and coke, with prices very firm. The new Town Hall at Barrow will be formally opened on the 14th of July by Lord Hartington. The Corporation of Barrow have been engaged for some months in the construction of a new road, being an extension of about a mile in length of the existing Abbey-road. It is full 80ft. wide, and will ultimately be planted on its sides with trees. When finished this road will extend from the centre of the town to Furness Abbey, a distance of three miles, with a uniform width of 80ft. It will then be one of the finest thoroughfares in the kingdom.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

SEVERAL leading firms continue to be very well employed on edge tools for the Continent, South America, and Australia. These markets have been in a satisfactory condition during the larger part of the year. Germany keeps an important customer, that country having the command of commerce in these goods throughout Southern Europe and an important portion of Eastern Europe. The very best class of goods go to Germany, though it is to German markets we owe the inferior qualities which compete with English articles in the home markets. In fine, the reliable English tools are used to fabricate the low-class goods which in several districts flood the markets. In South America a most noticeable and gratifying feature is the gradual decline in the demand for cheap products. Not so very long ago, none but the low-priced wares were sold in any quantity; now the call is all the other way. Like other customers, South America is finding out that the tools which last the longest are the cheapest in the end. In sheep shears, the Australian season, which begins in December and ends in March, is succeeded by the South American trade, the latter continuing until June. The English—*i.e.*, the home trade—lasts from January to April. The Australian season has only been moderate, and the South American business, with one or two exceptions, has been quieter than was anticipated. At the Cape, a distinct improvement has been evident for some time in all departments of business, and sheep shears have participated in the prosperity. The success of the gold mines and other enterprises has been the main factor in producing the animation which now prevails. Every kind of tool used in the opening up of the new undertakings is in request, and such articles as picks, spades, shovels, with mining appliances generally, are sold as soon as they arrive.

Mr. Emerson Bainbridge, of Sheffield, whose mission to Germany in regard to a new explosive for use in underground workings I have already mentioned, will report that the German invention has important properties which are of great consequence to coal mining in England. Mr. Bainbridge, I believe, became acquainted with other explosives, the merits of which he had opportunities of investigating during his investigations. Of these more will afterwards be heard.

Messrs. John Brown and Co. have at work their new hydraulic forging press and other machinery for producing large forgings for military and marine purposes. They had their first squeeze on the 24th inst., with very satisfactory results, though a little hitch occurred in the bursting of a small pipe. At the shareholders' meeting on the following day, the chairman, Mr. J. D. Ellis, called particular attention to this press and the engines connected with it, as well as some magnificent lathes put into their fitting shops by Hulse and Shanks. Mr. H. D. Pochin, one of the directors, expressed the opinion that there would be a large trade for the extensions now being made at the Atlas Works. People were crying out that the Government were badly supplied with guns, that they had forts for which they had no guns, and that there must consequently be a large demand. The Royal Commission on Ordnance had recently been in Sheffield, and had been greatly satisfied with the way John Brown and Co. were preparing for this business. The chairman, in reply to a question put by a shareholder, said he did not think there was much danger of Woolwich manufacturing forgings to any considerable extent. At the Woolwich Arsenal forgings were being made in small sizes, but machinery was not being put up for large sizes, and there was not much probability of their doing so, at least, so long as the present Government were at the helm of affairs. He reminded the shareholders that the machinery was not for gun forgings exclusively. Every large ship needed heavy shafting for working the screws and cranks of engines, so that there would be a continual demand, irrespective of large forgings for the Government.

Within a few years two important trades have been practically lost to Sheffield as to other inland towns. The steel rail trade for export can no longer be done successfully so far from the seaboard. Messrs. Charles Cammell and Co. adopted the bold course of transferring their export rail trade to Workington. Rails are still made in this district for the home companies, by Messrs. Cammell and Co., at Penistone; Messrs. Steel, Peech, and Tozer, at the Phœnix Bessemer Works, The Ickles, Rotherham; and Messrs. S. Fox and Co., at Stocksbridge Works, Deepcar; but the business is reduced to very small proportions, compared with what it once was. The steel ship plate trade has gone, for precisely the same Spanish ore goes to Middlesbrough, and if it enters there, or any other port, it has to come by rail to Sheffield. Thus the Sheffield firms are under the double disadvantage of having to pay carriage for the raw material to Sheffield and of the manufactured product to the port of delivery. It is therefore utterly impossible for a firm situated in the Midlands to compete in steel ship plates with the Steel Company of Scotland, the Consett Iron Company, or Messrs. Bolckow, Vaughan, and Co.

The Midland Railway Company having adopted the short-time movement for its draymen, the latter are now labouring to assist their brethren in the employ of the Manchester, Sheffield, and Lincolnshire Company to obtain similar concessions, and meetings are being held with that view.

Another trial of safety lamps took place at Sheffield on the 25th, on the invitation of Mr. Clifford, of the Clifford Lamp Company. A long and exhaustive notice of the experiments is given in the *Sheffield Telegraph*, which sums up by saying:—"Many of those present on Saturday were compelled to leave before the tests were concluded, but the feeling amongst those who remained was pretty unanimous in awarding to the Clifford lamp the premier honour of the afternoon."

Much regret has been expressed in business and other circles at the death of Mr. J. F. Barnaby, resident chief overseer of the Admiralty, who was well known in all the chief works here, and in a wide district extending to Middlesbrough. At the Government dockyards, and amongst marine engineers and shipbuilders generally, he was noted as one of the earliest and speediest advocates of mild steel for shipbuilding, instead of iron. He made careful and minute investigations into various disputed points, such as the effects of prolonged exposure to great heat, the working at a black heat, &c. These were afterwards adopted as conclusive and final. Deceased, who expired at the comparatively early age of fifty-four, was interred on the 24th. There were present at the interment his sons, Mr. John Barnaby and Mr. W. F. Barnaby; his brothers, Sir N. Barnaby, K.C.B., late Chief Constructor of the Navy; Mr. R. Barnaby, chief constructor, Chatham Yard; representatives of the Admiralty and the leading works of Sheffield, Leeds, Middlesbrough, &c.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Cleveland iron trade, the tone of which throughout last week was decidedly strong with advancing prices, became again weak on Tuesday last owing to the reaction reported from Glasgow. The attendance at Middlesbrough market was meagre, and No. 3 g.m.b. was sold by merchants at 34s. 6d. per ton, or 1½d. to 3d. less than they would have accepted at the end of last week. Makers, who have done a fair amount of business for ten days past on the basis of 35s. for No. 3, are now again holding off, and they refuse to lower their quotations. Forge iron can be obtained for 33s. 6d. per ton with prompt delivery.

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

The next quarterly market will be held at Middlesbrough on the 12th July.

Holders of warrants are quite as eager to sell as they were a week ago, and they are now willing to accept much lower prices. Last week they had no difficulty in obtaining 35s. 1½d. to 35s. 3d. per ton, but on Tuesday last 34s. 7½d. was the utmost which could be secured, and in one or two cases 34s. 6d. was taken.

The stock of pig iron in Messrs. Connal and Co.'s Middlesbrough store is again increasing rapidly. The quantity held on Monday last was 334,548 tons, representing an increase of 1237 tons during the week.

The pig iron shipments from Middlesbrough are scarcely up to the average for the time of year. Up to Monday night only 64,010 tons had been sent away, as against 70,637 tons in May and 72,152 tons in April.

But few inquiries have lately come to hand for finished iron, and prices are unaltered. Ship plates and common bars are still offered at £4 10s., and angles £4 5s. per ton, all free on trucks at makers' works, less 2½ per cent. discount.

The directors of the Manchester Ship Canal are endeavouring to arouse public opinion in favour of their enterprise by holding meetings at various centres of population, and explaining their plans and expectations. A meeting of this kind was held in the new police court at Middlesbrough on Monday last, and was attended by several of the leading ironmasters, engineers, and manufacturers of the district. Mr. J. F. Wilson, chairman of the Chamber of Commerce, presided, and Mr. Stevens, provisional manager of the Canal Company, explained at considerable length the nature of the project. He brought with him two colossal maps, and various drawings showing sections of the canal at several points in its route, as well as those of the other principal canals of the world. Discussion was invited and took place. Some further information was elicited as to the angle of the slopes, and the way in which it was intended to protect them from landslips; also on the long sea-wall which is to separate the lower end of the canal from the river Mersey, and the mode of construction thereof; also on the swing-bridge, whereby the Bridgwater Canal will be carried over near Barton. It was doubted by one speaker whether the canal will be of any special advantage to the Cleveland district; but the general feeling was that in affording fresh facilities for export it cannot fail to be of benefit, and that at any rate the expenditure of several millions of money and the employment of thousands of workmen must do something to remove the still prevalent depression of trade. A vote of thanks to Mr. Stevens concluded the meeting.

The day of issue of this journal will also mark the opening of one of the largest and most convenient railway stations in the country. It is at Darlington, the birthplace of railway enterprise, that the event, with great appropriateness, takes place. The new station is situated on the site of the old one at Bank Top, and will henceforth be the focus of arrival and departure of trains from and to whatsoever quarter of the locality. The Northgate, or 'Quakers" station, as it is still familiarly called, will become merely a subsidiary one, and will henceforth only be concerned in traffic going westward. On the arrival of trains from the north and south at the new station, the passengers will find waiting for them other trains for Saltburn, Richmond, Bishop Aukland, and Barnard Castle; and in the case of the first-mentioned destination, much time will be saved by avoiding the necessity which has hitherto existed for making a short journey to the Northgate station before the journey proper could be commenced. To effect this desirable change a new line of about six miles in length has been made from Banktop to a point in the Darlington and Stockton section between Fighting Cocks and Egglescliffe, thus cutting off an inconvenient corner and considerably shortening the route. On this branch a new station, called Dinsdale, has been built, from which access to the charming little watering-place of the same name willl be greatly improved. The new station is an "island" one. The roof is 1000ft. long by 180ft. broad, and is in three spans. It is nearly straight from end to end. At the north end, under the centre span, is a large space for carriages and cabs to await occupants. This space is reached by an inclined road, which at the lower end branches right and left under the railway. Changes from one train to another will be made without any crossing of the lines either by bridges or tunnels. The new station has been designed under the supervision of Mr. T. E. Harrison, chief engineer to the N.E.R. Company, by Mr. W. Bell, their architect. The contractors who have executed the various works are Messrs. Walter Scott and Co., of Newcastle, James Thompson and Co., of Leeds, and Butter Brothers, of Stanningley.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been a very material reaction in the state of the Scotch iron market since the date of last report. During the whole of last week the market was more or less strong, and the cash quotation of Scotch warrants ultimately advanced to 43s. 3d. per ton, the highest rate that has been touched for several months past. The advance was of a speculative nature, being due to the continued reports as to increased inquiries from Canada and the United States. Considerable doubt was cast by the bears on the value of these reports, and the contention that they were exaggerated appeared to be confirmed early this week, when the returns of the past week's pig iron shipments were obtained. The shipments turned out to be abnormally small—much less, indeed, than any that were previously reported during the present year. They were only 2546 foreign and 805 coastwise, the total of 3351 comparing with 5694 tons in the same week of 1886. In consequence of these meagre figures, the belief in a possible revival of demand from the United States and Canada was much shaken, and the result has been a smart fall in warrants.

Three furnaces that have been out of blast at Langloan Ironworks for some time, in consequence of an accident to the blowing machinery, have again been put in operation, and there are now 83 in operation, compared with 80 in the preceding week and 86 in the same week of 1886.

The values of makers' pigs, which were advanced last week by 6d. to 1s. per ton, are again easier, as follows:—Gartsherrie, f.o.b., at Glasgow, per ton, No. 1, 49s.; No. 3, 44s. 6d.; Coltness, 54s. 6d. and 44s. 6d.; Langloan, 50s. 6d. and 46s.; Summerlee, 52s. 6d. and 43s. 6d.; Calder, 49s. 6d. and 43s.; Carnbroe, 44s. and 40s. 6d.; Clyde, 46s. 6d. and 41s.; Monkland, 43s. 6d. and 39s.; Govan at Broomielaw, 43s. 6d. and 39s.; Shotts at Leith, 49s. and 45s. 6d.; Carron at Grangemouth, 52s. and 44s. 6d.; Glengarnock at Ardrossan, 47s. and 41s.; Eglinton, 43s. 3d. and 39s. 3d.; Dalmellington, 44s. and 40s. 6d.

The smallness of the shipments and the increase in the output lead to a larger addition being made to the pig iron stocks.

The steel trade of the West of Scotland is fairly active generally, while several works are quite busy. So far, there has this season been very little interruption to work from labour disputes, any little differences that occurred being amicably arranged. But within the last few days the charge wheelers in the employment of the Steel Company of Scotland at their Newton Works, near Glasgow, have been on strike, with the result that the whole of the melting furnaces were stopped. Unless the matter is arranged, it is likely to assume a serious form in a short time, other departments being so much dependent upon that which is directly affected by the strike.

The past week's shipments of iron and steel goods from Glasgow, embraced two steam launches, valued at £2400, for Colon; a stern wheel steamer, £1905, for Singapore; £4837 worth of machinery, of which a considerable proportion was sugar-crushing plant, for Demerara; £3213 sewing machines, £12,200 steel goods, and £30,100 general iron manufactures, of which £10,220 went to Canada.

The representatives of the Scottish mineral oil companies have entered into an agreement to advance the wholesale price of burning oils about ¼d. per gallon, and this is estimated to increase their combined revenue by £40,000 in the course of the year. An effort is also being made to bring about an amalgamation of all the companies, so as to save expenses of management, but it is not considered that this endeavour will be successful.

The coal trade is quiet in the inland department as a result of the very warm weather, but the shipments are fairly satisfactory. In the past week there was despatched from Glasgow 22,970 tons; Greenock, 1887; Ayr, 8025: Irvine, 1293; Troon, 5136; Burntisland, 19,800; Leith, 7220; Grangemouth, 15,678; Bo'ness, 5847; and Granton, 1697; total, 89,553 tons, against 79,125 in the corresponding week of last year.

The coal-masters of Lanarkshire have resolved to reduce the colliers' wages by 7½ per cent. from July 1st.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE want of water is beginning to make itself most grievously felt. In tin-plate operations water figures considerably, and, as a consequence, there are many of the works closing temporarily. I hear of works at Port Talbot and Llanelly in this predicament. Amongst the steel works, Dowlais suffers as badly as any, though the arrangements for possible contingencies are as good as could be well imagined. But this drought is an unusual one. Swansea is suffering so acutely that the matter came before the House of Parliament this week. Recourse is now being had to old collieries for drinking water, and pumping operations upon an extensive scale are going on. I doubt whether the water is as pure from old collieries as it is certified to be. Disused stalls are generally noisome. Then there are the stables, and the unavoidables that may be expected where three or four hundred men are working together. It is suggested that the sea and the usual appliances for converting sea water into safe water for drinking would give a more satisfactory supply. Dowlais works will be at a complete stop if the drought continue. The week has been as busy as could be with this drawback. Pumping back the water and using it over and over again is resorted to, but clean water does better service.

The coal trade is in one of its periodical spurts. Prices have literally jumped up 2s. per ton for best coal. This week 10s. 6d. is a common quotation, f.o.b. Cardiff. The bound is regarded as a doubtful one. More satisfaction would have been felt if prices advanced by 3d. and 6d. per ton, but at the same time coalowners are thankful, and are doing their best to reap the advantage. Last week, though broken, showed an export of 150,000 tons from Cardiff alone. So far, it is Cardiff which is chiefly in the enjoyment of the rise, but Newport and Swansea will follow suit. House coal is slack.

Most of the Dowlais colliers kept away from work on Monday, and rumours of a strike began to spread, which, as they are about 4000 in number, arouses a good deal of alarm. Fortunately, they resumed work on Tuesday, and have postponed discussing an old grievance. The Sir George pit, New Tredegar, will close at the end of the month, it is feared, unless the manager, Mr. Hann, consents to arbitration.

If the turn of the tide in the coal trade has come, it is fitting that it should begin with a benefit to men and masters. The announcement on Saturday of an advance in price was made at the same meeting of coalowners and representatives, held in Cardiff, where the decision of the arbitrator was given that the wages of the colliers should remain unchanged. It was feared that a drop of 2½ or even 5 per cent. was imminent.

The address of the colliers of South Wales to her Majesty on the Jubilee was conceived in good taste, and expresses very pertinently their loyal feelings. It was presented by Sir W. T. Lewis, who is accepted from one part of the great coal-field to the other as the representative of coal.

In *re* the Mines Regulation Bill, the concessions by the Home Secretary to the coalowners are approved of, but it is imperative that none of the objectionable clauses in the Bill be retained. One district, that of Merthyr, Dowlais, and Plymouth, would be a great sufferer.

While on the subject of coal, I may be permitted to ask, how is it, seeing that all authorities agree that coal dust is an extender of explosions, that a systematic adoption of the best means for wetting is not resorted to? There are various patents before the public, notably one by Kirkhouse and Lewis, of South Wales. It has been suggested that a company should be formed, which all coalowners should be invited to join, and the trams be forthwith made freely.

The improved start in the iron and steel trades is telling favourably. Treforest steel works are not a long way from starting, and this week an announcement has been made that the steam mills at Melingriffith will be started at once. This will give employment to a considerable number of hands.

A steam vessel is at Cardiff this week loading with patent fuel. It is one of Sir William Armstrong's productions, is of steel, and has a gross tonnage of 4500 tons. The ship is engined on the triple expansion principle by the Wallsend Slipway Company, of Newcastle and Cardiff.

The floating dock for Cardiff is now complete, and will arrive forthwith. Next month the Marquis of Bute is expected to preside at the opening of the new dock, a project which will place Cardiff in a position of great superiority if a burst of good trade is now at hand. This will come in most acceptably, and will show how well the scheme was justified.

The tin-plate is having a capital innings. Most holders of stocks are being rapidly cleared out, and the best makers have as much as they can do. Prices are stiff and advancing. Cokes, from 13s., nothing under; Bessemers, from 13s. 3d.; Siemens, from 13s. 6d. These quotations are not expected to remain, especially if tin continues to go up. It is now at £107. This activity in the tin-plate trade tells well on the steel works, and large orders for tin-bar are being placed. Terne plates are selling much more freely. Charcoal easy.

Stocks will be very low at Swansea at the end of this week.

Some idea of the "big ships" in the coal trade may be given by the fact that thirteen steamers are now loading in Cardiff with a carrying power in the aggregate of 60,000 tons. These are in Roath basin.

Swansea is exporting large cargoes of patent fuel to Russia. The trade is getting better.

Pitwood is quoted at 14s. 9d.; small steam coal, 4s. 3d.; small bituminous, at 5s. 9d.

The Great Western Railway is arranging for the South Wales day mails to London to run through the Severn Tunnel in July.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE momentary position of the iron markets is anything but satisfactory. It is true that for rolled iron the situation is tolerable, and the mills have enough orders on their books to keep them steadily at work; but pig iron is in a very depressed condition, for in spite of the great fall in the prices at the Rhenish-Westphalian and Siegerland Works, the demand has not been stimulated, and sales have been slow and far between. In Silesia as well, the reports concerning the forge pig iron trade particularly are unfavourable, inasmuch as an over-production in this sort has ensued, on account of no fresh outlet having as yet been found for it, and both buyers and speculators, under the circumstances, not coming freely forward, though offers at M. 43 to 45 are much pressed. Foundry pig is better situated, as the machine shops and foundries are busy, and it is noted at M. 48 to 53 for special brands. The continued good demand for all kinds and sections of wrought iron, stimulated in some degree by the good flow of water in the Oder to the Baltic towns, keeps the rolling mills and forges in full employment, bars being quoted as base price at M. 127·50 to 140 for superior sorts, and coke plates at 150 to 160, which prices are easily realised. In Austria the iron market has all along been, and still is, stable, with prices firm and tending to a rise, because the works have been wise enough to suit the production to the demand.

A shadow has been cast over the ore markets of the Rhenish districts in consequence of the depressed condition of the crude iron trade, and the demand has slackened materially, while the latest prices, which range for various sorts from M. 8 to 11·50, for calcined steel-stone, can barely be upheld.

It is evident that no drop in prices will ever bring more buyers into a market where over-production is dominant, and here is an exemplification of the rule now in progress, for purchasers of forge pig are hanging back in the expectation of still further concessions before they will come forward to satisfy their future requirements. Common Westphalian forge is noted M. 41; white steel-iron, 41 to 42; best forge 43·50; Siegerland brands, 42 to 43; spiegeleisen, 47 to 55 up to 67, with 20 p.c. Mn. at works, prices which are difficult to maintain, as the foreign demand for the latter sort is very confined just at present. Foundry pig is M. 49 to 55 for the three numbers; Bessemer, 50 to 51; the demand for both sorts having shrunk a little. Luxemburg forge is 32 to 33 p.t. The outlook in the mills and forges is much more cheering than that at the smelting works. The former were well employed, as a rule, before, but quite lately a great influx of orders for sectional iron has come to hand, especially for girders and constructional iron, so that some works are exceptionally busy, and in consequence the quoted prices are readily obtainable from the buyers. The much talked-of coalition convention has now, after endless meetings, become an accomplished fact, to commence on August 1st, but the base price of wrought iron bars is to be raised to M. 112 from July 1st. It will be instructive to note what the ultimate result will be. There is no great change to note in boiler plates. Not all the works are equally engaged, though most are busy, and latterly a better sustained demand has ruled. The ground price for 5½ m.m. gauge and above remains at M. 145 p.t., and there are no alterations from last notations for those in mild steel. The demand for thin plates and sheets is good, but so much is on offer that all that can be done is to maintain the price at M. 128 p.t. There is nothing new concerning wire rods. The export demand is wanting and keenly felt. Iron wire rods cost M. 110, steel 108 to 110, and drawn wire in either metal 125 to 128. Common merchant bars cost 110, base price; angles, 111 to 115; iron hoops, 115; steel billets, 110 to 122 p.t. In railway material, at Hanover the lowest offers at works were for steel sleepers, minus the holes, for placing under points and crossings, M. 122, point and crossing under-plates 109·90, steel rails for points 122½, and steel fish-plates 103·90 p.t. Light rails are M. 110 p.t. A few of the machine shops and foundries are pretty full of work, while others are only moderately well off for orders, and as a whole the quantity of work in hand leaves much to be desired. The wagon works are by no means busy. At a tendering at Milan for 870 freight wagons, Belgian works offered the lowest prices, while 650 covered freight cars fell to the lot of four German firms. The State Railways Administration at Elberfeld has sent out tenders for twenty-four passenger and post coaches for Elberfeld and twenty-nine of the former for Altona.

The most important feature of the Belgian iron trade is the agreement come to to prolong, with slight modifications, the present iron syndicate, for another year, on the same lines as hitherto. Steel plates will, in consequence of close German competition, be kept out of the convention, and girders, which are now such brisk request, are to be raised in price. A minimum price has been already fixed upon for bars, sectional iron, and plates, but up to this the regulation of the output of girders has chiefly occupied the attention of the committee. Forge pig, in consequence of the renewal of the syndicate, has become quite firm again at 42f. p.t. The machine shops are moderately employed, while the wagon works are only indifferently so.

The French iron market is so far in a more satisfactory condition that the endeavours to lower prices have everywhere been checked. On the whole buyers seem reluctant to make purchases. The ironworks of the Nord are insufficiently employed, but do not press sales. Girders are quoted at 125, merchant bars 135, and old rails 80 firm p.t.

STEAM BOILERS BILL.—Among the members of the House of Commons interested in the mercantile marine a strong opposition to the Steam Boilers Bill—which it is understood is about to be introduced in the House of Lords—is being organised. The object of the Bill is to empower the Board of Trade to annually inspect the boilers of steamers, and this is complained of as undue interference, seeing that the engineers hold Board of Trade certificates. The principle of the Bill was condemned at a meeting last week at Lloyd's, and on Tuesday shipping representatives from all parts of the kingdom met in the City to enter their protest against the measure.

THE EXPLOSION ON BOARD A TORPEDO BOAT.—Mr. R. R. Rodd, senior county coroner, reopened the inquiry at the St. George's-hall, Stonehouse, on Wednesday, into the circumstances attending the death of Frederick Platt, engine-room artificer, John Abbinett, stoker, and Henry Hawkins, leading stoker, through injuries received in May last on board the first-class torpedo boat No. 47 by an explosion, which occurred while the vessel with the rest of the fleet was on a forced draught run from Portland to Torbay and back. The jury found—"That the deceased died from the effect of burns received in the stokehole of the boat, and that the origin of the disaster was the neglect to supply the boiler with water, and that through this neglect the crown of the furnace became partially fused, in consequence of which the stays were drawn and a considerable portion of the plate forced down into the furnace. The fatal result is chiefly attributable to the fact that the deceased leading stoker, Henry Hawkins, for the purpose of increasing the speed by means of an increased draught, ordered the automatic doors of the ash-pit to be fastened back, which doors, had they not been fastened back, would have prevented the escape of the flames from the furnace into the stokehole." To this verdict the jury appended the following rider:—"That, in our opinion, the practice of offering rewards to the artificers and stokers for the purpose of inducing them to obtain the highest possible speed, and thus endanger the lives of all on board, is one to be severely deprecated, and that this rider be forwarded to the proper quarter."

NAVAL ENGINEER APPOINTMENTS.—The following engineer appointments have been made at the Admiralty, many of them being in consequence of the coming review:—W. H. C. Gale, chief engineer, to the Helicon, to date July 5th; John Fielder, engineer, to the Victoria; Lawrence Bell, assistant engineer, to the Amphion; Charles Underhill, assistant engineer, to the Sanspareil; W. R. M'Avory, fleet engineer, to the Hydra, to date July 12th; E. J. Comley, fleet engineer, to the Mersey, to date June 28th; W. P. Davis, fleet engineer, to the Collingwood; George J. Weeks, fleet engineer, to the Edinburgh, to date July 1st; W. M. Peak, fleet engineer, to the Gorgon, to date July 5th; H. Hull, fleet engineer, to the Inflexible, to date July 1st; G. E. M. Keey, fleet engineer, to the Black Prince; James Ireland, fleet engineer, to the Conqueror; Charles Platt, fleet engineer, to the Inconstant; R. C. Widdicombe, fleet engineer, to the Prince Albert, all to date July 5th; Samuel J. Rock, staff engineer, to the Cyclops; A. J. Allen, staff engineer, to the Mercury; T. W. H. Ramsay, staff engineer, to the Amphion, all to date July 5th; G. A. Haddy, chief engineer, to the Arethusa, to date July 8th; T. New, chief engineer, to the Mohawk, to date July 5th; W. R. Rock, chief engineer, to the Fearless, to date July 7th; Stephen Hocky, engineer, to the Arethusa, to date July 8th; J. W. Allen, engineer, to the Hydra, to date July 12th; A. D. Watson, engineer, to the Mersey, to date June 28th; H. Wallis, engineer, to the Mohawk, to date July 5th; F. W. Wells and J. M. Thompson, engineers, to the Collingwood, to date July 1st; D. Griffin, engineer, to the Cyclops, to date July 5th; Joseph H. Pill, and W. G. Tazewill, engineers, to the Edinburgh, to date July 1st; C. A. Harding, engineer, to the Fearless, to date July 7th; F. W. Hawkins, engineer, to the Gorgon, to date July 5th; Hugh Hawkins, engineer, to the Impérieuse, to date July 7th; James Shirwell and E. J. Taylor, engineers, to the Inflexible, to date July 1st; Albert V. Blake, engineer, to the Mercury; J. R. J. Pedrick, engineer, to the Amphion; R. T. Serle, engineer, to the Black Prince, all to date July 5th; W. Lonnon, engineer, to the Bramble, to date July 2nd; J. G. L. Baker, engineer, to the Conqueror; W. A. Howlett, engineer, to the Inconstant, to date July 5th; J. E. D. Graham, engineer, to the Jackal, to date June 25th; Alfred Hart and J. A. Hibbard, assistant engineers, to the Arethusa, to date July 8th; H. Humphreys and E. J. Edgar, assistant engineers, to the Mersey, to date June 28th; H. Abbot, engineer, to the Mohawk, to date July 5th; S. A. Houghton and W. Whittingham, engineers, to the Collingwood, to date July 1st; F. T. George and M. Blakeman, engineers, to the Edinburgh, to date July 1st; W. R. Apps, engineer, to the Fearless, to date July 7th; H. P. Vining, W. Snell, and C. J. James, engineers, to the Impérieuse, to date July 7th; C. A. Moore and B. J. Watkins, engineers, to the Inflexible, to date July 1st; R. W. Jones and T. R. Reynolds, engineers, to the Mercury; L. Bell and C. H Collins, engineers, to the Amphion; C. B. Lecky, engineer, to the Black Prince; W. H. Adams and A. E. C. Deacon, engineers, to the Conquerer; M. Stewart, engineer, to the Inconstant; and W. J. Hender, engineer, to the Prince Albert, all to date July 5th.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, June 20th.

THE prospects for heavy importations of all kinds of foreign material are better than they have been for several months. The contracts for English Bessemer have already gone abroad, and there are inquiries in hand this week from large buyers well known to importers, who are making inquiries with a view to extensive contracts. Orders for Bessemer could be placed at 19·50 dols.; for spiegeleisen, at 27 dols. to 27·25 dols. Three or four contracts for foreign rails have been placed at 40·50 dols. at gulf ports. Steel blooms are quoted at 29 dols., which is 1 dol. above buyers' views. Billets and slabs would bring 29 dols.; wire rods are quoted at 40 dols.; tees are held at 21·50 dols., with 21 dols. offered; double-heads are 22 dols., with sales at 21·50 dols.

There are prospects of heavy operations both in foreign and American metal markets. Structural iron makers have been booking heavy orders, and it is said on good authority that during the next thirty days upwards of 20,000 tons of bridge-building material will be contracted for. The reason for this unusual activity is to be found in the fact that the dulness of the American iron market for the past few weeks has brought about a slight depression in prices, and railroad bridge builders and others are taking advantage of the drop to cover requirements for the next three to six months. Copper is selling at 10c. for Lake. Lead is in active demand and firm at 4·70. The production of the silver, gold, and lead mines throughout the west and south-west is increasing under improved management and better machinery.

Reports from Chicago show a decline in bar iron, and boiler plates and tank active. Steel rails are selling at 43 dols. at East St. Louis. The architectural ironworks throughout the West, pipe works and stove foundries, are all looking for supplies, and in consequence there is more strength in the St. Louis market than for a month. Prices of merchant steel are firm throughout the West, on account of the large orders that have been placed for agricultural implements and tools.

The ironworks, foundries, and shops throughout the Ohio Valley are being affected by the scarcity of coke in Western Pennsylvania, and labour is being disemployed in consequence. It is estimated that by July 1st, should the strike continue, production of crude iron will have been decreased to the extent of 55,000 tons per week, and upwards of 50,000 workmen will be disemployed. Apart from this strike, the manufacturing and trade conditions throughout the country are of a favourable character. Money is abundant, confidence is strong, consumption of all kinds of manufactured products is heavy, crop reports are favourable, and the general trade conditions indicate that the present activity will continue to the close of the year.

NEW COMPANIES.

THE following companies have just been registered:—

Aluminium Company, Limited.

This company was registered on the 18th inst., with a capital of £400,000, in £5 shares, to purchase the inventions and patent rights of Mr. James Webster, for the manufacture of alumina, aluminium, and certain metallic alloys and compounds, together with the business of Webster's Patent Aluminium Crown Metal Company, Limited. The subscribers are:—

	Shares.
*Lieutenant-General G. W. Balfour, M.P., 32, Addison-road	1
*Sir Andrew Clarke, R.E., 52, Portland-place	1
*W. Anderson, C.E., 3, Whitehall-place	1
*W. Mactaggart, 24, Leadenhall-street, merchant	1
*H. Y. Castner, 5, Belvedere-road, Lambeth, chemical engineer	1
P. F. Tidman, C.M.C., Chislehurst	1
F. S. Courtney, C.E., Palace-chambers, Westminster	1

The number of directors is not to be less than five, nor more than nine; the first are Sir H. E. Roscoe and the subscribers denoted by an asterisk; qualification, 200 shares, or £1000 stock; remuneration £2500 per annum.

Anglo-Portuguese Gas and Water Company, Limited.

This company proposes to carry on in Portugal and elsewhere the business of suppliers of gas, water, and electric light, and of hydraulic and electric force, and in particular to acquire two concessions for the supply of gas and water to the town of Figuerra da Foz, Portugal, granted by the Municipality of that town. It was registered on the 17th inst., with a capital of £100,000, in £5 shares. The subscribers are:—

	Shares.
*R. Murdoch, Glasgow, merchant	200
*R. Laidlaw, Glasgow, engineer	200
*A. F. Phillips, C.E., St. Albans	200
*T. C. Horsey, C.E., Preston Park, Brighton	200
*H. P. Mundey, 73, Linden-gardens, Bayswater	200
T. N. Kirkham, C.E., 7, Palace-chambers, Westminster	20
J. M. Smith, 6, Crosby-square, accountant	1

The number of directors is not to be less than three, nor more than seven; qualification, 200 shares; remuneration, £150 per annum, with an additional £50 for each 1 per cent. dividend upon the ordinary shares exceeding £10 per cent. per annum, and such further sum as the company in general meeting may determine.

Potosi, Limited.

This is the reconstruction of the New Potosi Company, Limited, whose mines, situate in the State of Guayana, Venezuela, will be taken over. It was registered on the 17th inst., with a capital of £400,000, in £1 shares. The present company will discharge the debts and liabilities of the old, and will issue one new fully-paid preference share in exchange for each preference share held in the old company, and one ordinary share credited with 16s. paid up in respect of each ordinary share in the old company. The subscribers are:—

	Shares.
*S. F. Somes, 55, Old Broad-street, merchant	1
*G. J. Duff, 58, Queen's-gate	1
*H. W. Scriven, 34, Great St. Helens, foreign banker	1
*E. D. Matthews, C.E., 10 and 11, Union-court-chambers	1
*H. Smith, jun., M.E., 5, Union-court	1
J. R. Wilkinson, 42, New Broad-street, accountant	1
P. Hart, 16, Devonshire-square, E.C., solicitor	1

The number of directors is not to be less than three, nor more than nine; qualification, £500 of share capital; the first are the subscribers denoted by an asterisk, and Mr. Wm. Nevett; remuneration, £300 per annum for the chairman, and £200 for each director, and a further consolidated sum of £1000 in each year in which 20 per cent. dividend is paid.

Machine Cooperage Company, Limited.

This company was registered on the 17th inst., with a capital of £15,000, in £1 shares, to acquire the invention of J. H. Hall and Dennis Parry, for improvements relating to machine for making casks and barrels. The subscribers are:—

	Shares.
*J. H. Hall, Sidcup, commission agent	1
A. M. Levy, M.E., 37, Bassett-road, W.	1
*F. B. Carritt, 23, Rood-lane	1
D. Parry, Llandegla, near Mold, millwright	1
F. W. Chuck, Wakefield-road, South Tottenham, solicitor	1
E. Carritt, 18, Great St Helens, architect, &c.	1
W. K. Gilmore, 161, Brook-road, Clapton, civil servant	1

The subscribers denoted by an asterisk are appointed directors; qualification, 100 shares. The company in general meeting will determine remuneration.

Magnetic Bell and Signal Company, Limited.

This company was registered on the 16th inst., with a capital of £100,000, in £1 shares, to acquire patent rights for electrical inventions, or for appliances to be used in connection therewith. The subscribers are:—

	Shares.
J. R. Blundstone, Victoria Mansions, Westminster, engineer	1
J. Harker McKean, 113, Angell-road, S.W., advertising contractor	1
C. J. Daniell, King's Langley, Herts	1
J. Allison, 139, Hungerford-road, N., secretary to a company	1
C. Spicer, 20, Old Broad-street, clerk to an insurance company	1
H. J. Smith, 16, Dorset-road, South Lambeth, clerk	1
F. W. Bridges, 120, Cloudesley-road, N., clerk	1

The number of directors is not to be less than three, nor more than nine, and three of the first are to be appointed by the Compagnie de Signaux Magnetiques et Communication Telephonique de Paris; qualification for ordinary directors other than the first, 100 shares; remuneration, £150 per annum each director, with an additional £150 for the chairman.

THE GROWTH OF AMERICAN CITIES.—The following table shows the enormous growth of the three principal cities in the United States:—

Year.	New York.	Philadelphia.	Chicago.
1830	238,000	188,800	45
1840	398,500	261,500	4,400
1850	766,700	432,300	34,500
1860	1,332,700	599,800	122,700
1870	1,760,100	706,800	321,500
1880	2,303,600	894,900	572,600

It should be added that the inhabitants of Brooklyn, Jersey City, and Hoboken are included in the above totals for New York, while the territory between Hyde Park and Evanston is included as part of Chicago. While during the last half-century the population of Philadelphia has increased nearly fivefold, and that of New York tenfold, Chicago may be said without exaggeration to have literally come into existence, its growth being from 45 in 1830 to 572,600 in 1880.

CANADIAN IMPORTS OF IRON.—With regard to the statements in the course of the discussion on the tariff changes in Canada, that the imports of iron and steel and manufactures of that article from Great Britain were decreasing, while those from the United States were increasing, the following trade statistics show that the United States have, during the past ten years, succeeded in obtaining a large portion of Canadian trade in those classes into which skilled labour enters most largely. For instance, in machinery, such as sewing machines and locomotives, the yearly average of imports from Great Britain from 1877 to 1886 has been £19,980, but the value for last year was only £11,895. The United States, in the same period, have sent such goods of an annual average value of £137,699, beginning in 1877 with £79,513. In hardware and cutlery, British imports have averaged £192,392 yearly, the amount last year being £182,860. The yearly average from the United States has been £368,184, beginning with £218,197 in 1877. In general machinery Great Britain has sent to Canada an annual average value of £65,747, last year's figures, however, being only £27,924. The imports from the United States in 1877 were £101,940, while their annual average value for the ten years has been £201,801. In castings and forgings the annual average value of imports from Great Britain has been £50,955, last year's figures being £44,173. The United States began with £9863 in 1877, while their yearly average is now £50,955. In steel rails, which are still admitted free, Great Britain has sent to Canada in the last ten years, including rail fastenings, a yearly average value of £445,415, against an annual average value of £73,965 from the United States for the same period. It is expected that, while the proposed tariff changes will tend to develope the immense coal and iron fields of Canada, the general result will also be to increase the trade between Great Britain and the Dominion in many of those manufactures which at the present time are being imported more largely from the United States.

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.

22nd June, 1887.

8873. PEDAL ATTACHMENTS for ORGANS, L. A. Subers, London.
8874. SOWING GRAIN, J. E. Weyman and D. Macfarlane, Guildford.
8875. TEA DRYING MACHINES, A. H. B. Sharpe, Gainsborough.
8876. GAS STOVE for DOMESTIC PURPOSES, J. Galli, Bradford.
8877. ASSISTING PERSONS in RISING, W. J. Tanner, London.
8878. REVOLVING TOY FIGURES, &c., G. Dean, Dukinfield.
8879. ATTACHMENT for RAILWAY CARRIAGE SEATS, T. H. Brigg, Weston.
8880. VELOCIPEDES, M. Woodhead, P. Angois, and W. Ellis, Nottingham.
8881. PRINTING SHELLS, O. J. Smith, London.
8882. PICKING MECHANISM of POWER LOOMS, I. Sowden, Bradford.
8883. VALVES, J. Lewis, Manchester.
8884. ROTATING or OSCILLATING VALVES, J. Lewis, Manchester.
8885. SPINNING YARNS, J. M. Tankard and H. W. Broadbent, London.
8886. DESIGNS, J. Bentley and W. S. Simpson, Staffordshire.
8887. HANDLES, F. A. Harrison, Birmingham.
8888. POTTERS' SAGGARS, J. P. Guy, Longport.
8889. BOXES for CARTRIDGES, J. J. Speed, London.
8890. HEATING AIR in BUILDINGS, E. Renshaw, Manchester.
8891. PROPELLING SHIPS by a SCREW-PROPELLER, W. S. Price, Garston.
8892. LID, J. Ford, King's Lynn.
8893. OPERATING FAN-LIGHTS, &c., E. T. Owens, Birmingham.
8894. ANCHORS, J. I. and T. Cox, Saltney.
8895. GOVERNORS, &c., W. Elliott and W. Garrood, Beccles.
8896. MULTI-ARMED WEBBED REVOLVING ANCHOR, T. Ray, Sunderland.
8897. SELF-ACTING CHURN VENT, J. Mackenzie, Cork.
8898. WATERPROOF GARMENTS, W. Currie, Edinburgh.
8899. REELING YARNS, J. R. Donkersley, P. Wallace, and A. Vautrey, Halifax.
8900. FLOATS, H. Sutcliffe, Halifax.
8901. ENSURING the VENTILATION of ROOMS, W. H. White, Halifax.
8902. CIRCULAR KNITTING MACHINES, E. Frenzel, London.
8903. CRUSHING COLZA, W. P. Thompson.—(*C. Drevs, Germany.*)
8904. TRANSFERRING PAPER FILES, W. P. Thompson.—(*W. A. and C. S. Cooke, United States.*)
8905. PERFORATING PAPERS, W. P. Thompson.—(*W. A. and C. S. Cooke, United States.*)
8906. FILES, W. P. Thompson.—(*W. A. and C. S. Cooke, United States.*)
8907. INDEXES for FILES, W. P. Thompson.—(*W. A. Cooke, United States.*)
8908. DRESSING TABLES, J. Tirebuck, Liverpool.
8909. AUTOMATIC ROTARY BRUSHES, S. Kemp, London.
8910. COUPLINGS for FLEXIBLE TUBING, J. Cockburn, Glasgow.
8911. COTTON PICKING MACHINERY, W. H. Goldsmith, London.
8912. PLOUGHS, H. J. Haddan.—(*J. Oliver, United States.*)
8913. FRIGORIFIC PROCESSES, C. Possoz, London.
8914. METALLIC BUILDINGS, J. Dauly, London.
8915. WHEELS, E. E. de Facieu, London.
8916. PENHOLDERS, J. Y. Johnson.—(*The Eagle Pencil Company, United States.*)
8917. SMOKE and AIR EJECTORS, &c., T. S. Truss, London.
8918. MEASURING, H. H. Lake.—(*A. S. Adler, United States.*)
8919. WEIGHING MACHINES, M. Martini, London.
8920. TRICYCLES, G. H. Milward, Manchester.
8921. BISCUIT-BAKING MACHINES, J., J. A., W. K., and G. S. Baker, London.
8922. COBALT SULPHATE, W. N. Hartley and W. E. B. Blenkinsop, London.
8923. DRY CLOSETS, H. H. Lake.—(*L. B. Robb, United States.*)
8924. CAR COUPLING, J. A Richard, London.
8925. WATER METERS, G. Teideman, London.
8926. PRINTING TELEGRAPHS, S. Van B. Essick, London.
8927. KNITTING MACHINES, E. C. Covell and E. S. Cram, London.
8928. CARTRIDGES for FIRE-ARMS, F. Schelling, London.
8929. CHARCOAL for EXPLOSIVES, &c., H. Güttler, London.
8930. JOINING or UNITING METAL PLATES, F. C. Bellinger, London.
8931. SYPHONS for OIL-CANS, H. H. Lake.—(*C. N. Tyler, United States.*)
8932. SULPHURETTED DERIVATIVES from the AROMATIC OXY COMPOUNDS, A. Ewer, P. Pick, and M. Lange, London.

23rd June, 1887.

8933. REELS for BOLTING, SIFTING, &c., FLOUR, F. Bosshardt.—(*P. A. Outrequin, France.*)
8934. TOOL for MAKING a SCREW on the NECK of BOTTLES, M. G. and W. H. Thompson, Newcastle-on-Tyne.
8935. CHECKING and REGISTERING FARES, J. S. Ayton, Liverpool.
8936. ELECTRIC INCANDESCENCE LAMPS, G. H. Bays, Wakefield.
8937. PROPELLING by HAND-POWER, W. Palmer, Bath.
8938. CIRCULATION of WATER in STEAM BOILERS and HEATING of FEED-WATER, G. Donkin, B. G. Nichol, and H. Macarthy, Newcastle-on-Tyne.
8939. LAYING-DOWN CONCRETE PAVEMENTS, FLOORS, &c., J. and J. Crombie, Middlesbrough-on-Tees.
8940. TICKET HOLDERS, A. W. Turner, Birmingham.
8941. LOCK NUTS for SCREW BOLTS, W. Parker, Sheffield.
8942. BOOTS and SHOES, G. Shelton, Higham Ferrers, and F. Cutlan, Wellinborough.
8943. CONSUMING WASTE STEAM from TRAMWAY, &c., ENGINES, J. W. Needham, Birmingham.
8944. TRICYCLE, H. Edwards, Anglesey.
8945. DISTILLING APPARATUS for PRODUCING FRESH WATER from SEA WATER, S. Smillie, Glasgow.
8946. CAPSTANS, H. Fletcher, London.
8947. PURIFICATION of COTTON SEED OIL, G. Tall, Liverpool.
8948. IMPROVED BEARING for PREVENTING FRICTION, R. F. Campbell, London.
8949. REGENERATED LAMP for ILLUMINATION and HEATING, E. J. Palmer, London.
8950. CONNECTIONS for ELECTRICAL CONDUCTORS, R. O. Ritchie, London.
8951. SOUNDING HORN or TRUMPET, G. and M. A. Prince, Leeds.
8952. MECHANICAL TARGETS, A. P. Hensen, London
8953. GENERATING GAS for ILLUMINATIONS, &c., R. B. Avery, New York.
8954. DRIVING SPINDLES, J. Y. Johnson.—(*E. C. A. Masson-Pinel, France.*)
8955. COVER for HASSOCKS, &c , G. Davies, London.
8956. RIBBON, A. Blackburn, London.
8957. EXTRACTING, &c., METALS from ORES, H. Defty, London.
8958. BALANCES, E. Steinfeldt and F. Koch, Berlin.
8959. BRACES, E. Tomlinson, London.
8960. BUGLES, &c., J. Bénard, London.
8961. FORCE ACCUMULATING BRAKES, F. Jordan, London.
8962. SAUSAGES from FISH, F. Sievers and R. Damm, London.
8963. SEWING MACHINES, W. Beecroft, London.
8964. SEWING MACHINES, W. Jones, London.
8965. BURGLAR ALARM DETECTOR, R. W. Gamble London.
8966. SAFETY LAMPS, G. Smith, London.
8967. PACKING of VALVES or COCKS, A. P. Sampson, London.
8968. IRON and STEEL, J. Toussaint, London.
8969. PULP for PAPER, H. Gardner.—(*S. S. Stevens, United States.*)
8970. DYNAMITE CARTRIDGES, E. Grüne, London.
8971. ROVING MACHINES, J. Strauss, Germany.
8972. DELIVERY of ARTICLES, J. S. Wallace, London.
8973. MUSICAL INSTRUMENTS, J. H. Barry, London.

24th June, 1887.

5404A. FOG SIGNALLING APPARATUS, T. H. Richardson, London.—*14th April*, 1887. [Received 25th June, 1887. This application having been originally included in No. 5404, A.D. 1887, takes, under Patents Rule 23, that date.]
8974. SIZING WORSTED or other WARPS, R. Gledhill, Bradford.
8975. HOLDING PIPES, H. Munkel, Germany.
8976. RINGS for BUILDING YARN on BOBBINS, W. Stell, Bradford.
8977. ROLLER MILLS, F. Bosshardt.—(*MM. Texier et fils, France.*)
8978. SYPHON BOTTLES, F. A. Walton, Birmingham.
8979. SADDLES for SUPPORTING FALLERS, T. Chapman and J. Masker, Bradford.
8980. NAILS, S. Bott, Birmingham.
8981. PREVENTING the UNSCREWING of SCREWS, C. C. Wilson, West Bournemouth.
8982. FIRE-ESCAPES, E. A. Calvert, Chiswick.
8983. TIN BOXES, G. B. Sherriff, Glasgow.
8984. LAMP CHIMNEYS, T. Murtagh, London.
8985. DOTTING PENS, W. F. Stanley, London.
8986. REGULATING the TEMPERATURE of FERMENTING LIQUIDS, W. W. Davenport, Birmingham.
8987. BUFFERS for RAILWAYS, &c., T. H. Heard, Sheffield.
8988. STAY BUSKS, R. Simpson, H. Simpson, and B. G. Simpson, Sheffield.
8989. SHEEP SHEARS, R. Simpson, H. Simpson, and B. G. Simpson, Sheffield.
8990. ACTUATING MECHANISM of CARTRIDGE EXTRACTORS, C. H. Malcham, Sheffield.
8991. LOCK-UP FRAMES for BOTTLES, J. Ridge, Sheffield.
8992. LAYING TRAMWAY, &c., RAILS, W. E. Heath, London.
8993. RAILWAY CHAIRS and SLEEPERS, W. Wenström, London.
8994. TRANSMISSION of POWER and MOTION, M. Garland, London.
8995. SOLITAIRES and STUDS, W. A. Murray, London.
8996. BOOTS and SHOES, J. Ballington, London.
8997. SEWING STRAW BRAID, T. L. Kay and S. Douglas, London.
8998. ARTISTS' EASELS, A. K. Cross, London.
8999. FURNACE, W. Horsfall, London.
9000. EXTINGUISHING LAMPS, W. Linington, New Malden.
9001. RAMMERS used in BLASTING, &c., H. Johnson, London.
9002. CHANDELIERS, &c., A. Bellchambers, London.
9003. RECEPTION of COINS and DELIVERY of FLUIDS, G. C. Bingham.—(*C. H. Bingham, Holland.*)
9004. POSTAL PUBLICITY, J. B. Ville and E. François, London.
9005. STOPPERS for BOTTLES, A. R. Stocker, London.
9006. SEWING MACHINES, H. W. Snow.—(*H. Kånberg, Germany.*)
9007. STEERING GEAR, T. Paton, Glasgow.
9008. TURNIP-THINNING MACHINES, T. Wardlaw, Glasgow.
9009. OIL LAMP CHIMNEY GLASSES, F. Shorten.—(*M. Herrmann, Germany.*)
9010. BOTTLE STOPPERS, J. Roots, London.
9011. DYNAMO-ELECTRIC GENERATORS and MOTORS, E. Jones, London.
9012. EYELET for SEWING MACHINES, H. E. Newton.—(*The National Machine Company, Incorporated, United States.*)
9013. DYNAMO-ELECTRIC MACHINES, C. Coerper, London.
9014. WEAVERS' SHUTTLES, E. F. Schmirk, London.
9015. ATOMISERS, H. H. Lake.—(*A. P. Lighthill, United States.*)
9016. TYPE-WRITING MACHINES, J. S. Wallace, London.
9017. HEATING ORES, &c., by an ELECTRIC CURRENT, W. Cross, London.
9018. TYPE-WRITING MACHINES, H. H. Lake.—(*J. H. Currier and E. J. Blount, United States.*)
9019. TYPE-WRITERS, A. F. Kirk and A. Russell, London.
9020. STREET SCRAPER and CART, S. M. Stevenson, London.
9021. CASH or PARCEL CARRIERS, F. N. Jones and the Lamson Store Service Company, London.

25th June, 1887.

9022. FRAMES, &c., of ROUNDABOUTS for ADVERTISING, J. Bromley and T. Harrison, Leeds.
9023. RENDERING SEA-WATER FIT to DRINK, A. McDougall, Manchester.
9024. HINGED ROOFS for PETROLEUM LAMPS, F. S. Osmond and D. Matthews, London.
9025. ROLLER CASTOR, E. Bull, Halifax.
9026. ALUMINIUM CHLORIDE, J. A. B. Bennett and W. Sunderland, Birmingham.
9027. FIXING MORDANTS upon FIBRES, W. and J. Crowther, Dewsbury.
9028. COFFIN FURNITURE, W. G. Ingall and C. J. Parsons, Birmingham.
9029. LENO WEAVING, W. J. Riley, Manchester.
9030. VAPOUR INHALERS, R. M. Kennedy, London.
9031. INSULATION of ELECTRIC CONDUCTORS, A. J. Jarman and P. Dobson, London.
9032. TUBULAR RIVET and EYELET SETS, J. Brindley, London.
9033. RAILWAY SLEEPERS and CHAIRS, G. Guthrie, London.
9034. SASH LIFT and FASTENER, R. Whiston, Birmingham.
9035. REFLECTORS, W. Defries, London.
9036. WATER WASTE PREVENTING, W. Dennison, Glasgow.
9037. ELECTRIC LAMPS, T. P. C. Crampton and H. Thomas, London.
9038. AFFIXING POSTAGE STAMPS, &c., H. Ebuer, London.
9039. FACED BRICKS, F. Naumann, London.
9040. PURIFYING SEWER, &c., GASES, B. C. Badham, London.
9041. SORTING, &c., CHAIN LINKS, F. Hughes.—(*J. D Storie, Canada.*)
9042. CURTAIN RINGS, M. Nixon, London.
9043. DRIVING BELTS, R. Dick, Glasgow.
9044. AUTOMATIC PLAYING of KEY MUSICAL INSTRUMENTS, J. M. Grob, A. V. Niemczik, and A. O. Schuttze, London.
9045. IMPREGNATING BEER, O. Brünler and C. G. Rommenhöller, London.
9046. MIXING LIQUIDS, O. Brünler and C. G. Rommenhöller, London.
9047. PRESSURE REDUCING VALVES, O. Brünler and C. G. Rommenhöller, London.
9048. LIQUID CARBONIC ACID, O. Brünler and C. G. Rommenhöller, London.
9049. MIXING LIQUIDS, O. Brünler and C. G. Rommenhöller, London.
9050. TRICYCLES, &c., T., F., and E. Warwick, London.
9051. INK-WELL, M. S. Smith, C. H. and F. L. Cooke, and M. C. Bagby, London.

9052. Hay Rake, J. V. Gibbons, London.
9053. Wheels of Road Locomotives, I. A. Timmis, London.
9054. Chain Rail, A. J. Boult.—(*C. C. Klinik, F. Pinkowski, and A. Sollmann, Germany.*)
9055. Ratchet and Pawl Devices, W. A. Loud, Liverpool.
9056. Pumps, W. P. Thompson.—(*J. Olof, Sweden.*)
9057. Recording the Distance Run by Steamers, &c., M. Blair, Liverpool.
9058. Sewing Machines, F. O. Jerram, Liverpool.
9059. Rotary Engine for use as a Motor, Pump, or Blower, J. A. Wade and J. Langdon, Hornsea.
9060. Structures for Supporting Electric and other Lines, J. Hart.—(*M. J. Hart, United States.*)
9061. Automatically Actuating Gates and Signals, A. J. Martins, J. M. da Silva, jun., and A. de A. Neves, London.
9062. Pressure Gauges, K. Bradacz, London.
9063. Cutting Diamonds, &c., F. Nockold, London.
9064. Valves for Gases under High-pressure, J. Orchard, London.
9065. Joining Different Materials, L. Wilson, London
9066. Marine, &c., Boilers, J. F. Hall and J. Verity London.
9067. Motive-power, M. F. D. Cavalerie, London.
9068. Magic-lanterns, G. Carette, London.
9069. Stoppers, &c., H. Gautier and J. de Voyon, London.
9070. Tennis Nets, J. P. Helfenstein, jun., London.
9071. Pen for Lithographic Purposes, W. H. Emett, London.
9072. Machines Worked by Treadles, H. L. Hind, London.
9073. Pump, W. H. Gilruth, London.
9074. Making Plain Stoneware Pipes, W. H. L. Cooper, London.
9075. Riding Saddles, T. Bourne, Bristol.
9076. Telephone Exchange Switches, W. Moseley, London.
9077. Artificial Light, S. Pitt.—(*J. R. Knapp, United States.*)

27th June, 1887.

9078. Weighing Machines, W. S. Oliver, London.
9079. Metallic Protector for Boots, &c., J. Hewitt, Leicester.
9080. Moulds, S. Bunting, Dublin.
9081. Adjustable Pulleys and Wheels, J. Mitchell, London.
9082. Cap Holder, W. Greenwood, Manchester.
9083. Dress Improver, C. A. White, London.
9084. Obviating the Escape of Gases from Sewers, J. Warburton, Konigsburgh.
9085. Packing, T. Peat and J. Graham, London.
9086. Brakes, T. Singleton, London.
9087. Waterproof Fabrics, P. M. Matthew, jun., Edinburgh.
9088. Boots, N. Proctor, Derbyshire.
9089. Fabrics, G. Soar, Manchester.
9090. Winding Yarn, J. and W. Schofield, Oldham.
9091. Velocipedes, W. Golding, Manchester.
9092. Washing Bottles, C. B. Inman, Hunslet.
9093. Mixing Metals, J. A. B. Bennet and W. Sunderland, Birmingham.
9094. Trimming, J., J., and R. Redman, Halifax.
9095. Feed Regulator, A. Turnbull, Glasgow.
9096. Lenses, C. Knight, Newport.
9097. Scoring Cardboard, L. W. Stone, and E. Crowe, Banbury.
9098. Plates, S. Elston and A. Harrison, London.
9099. Wood Screw, T. R. Weston, London.
9100. Hats, &c., J. Davies, London.
9101. Bottles, H. F. Hill, Nottingham.
9102. Pumping, F. W. Dick and J. McL. McMurtrie, Glasgow.
9103. Electro-plating, J. Y. Johnson.—(*A. de Méritens, France.*)
9104. Motors, A. P. Trotter, H. W. Ravenshaw, and W. T. Goolden, London.
9105. Lubricators, J. Styblo, London.
9106. Measuring Casks, G. D. Ham, London.
9107. Protector, J. Hawthorn, London.
9108. Chain-cable, J. M. Dodge, London.
9109. Chain-cable, W. D. Ewart, London.
9110. Saddles, J. Wheeler, London.
9111. Gas-engine, R. Haddan.—(*P. Archat, France.*)
9112. Cultivation, R. Sack, London.
9113. Traveller's Companion, D. W. Hamper and T. Dyer, London.
9114. Butterfly Wings, E. Partridge, Birmingham.
9115. Knife Cleaners, V. Holt and F. H. Judson, London.
9116. Drinking Vessels, A. Sheldon, London.
9117. Joints, J. Sturgeon, Birmingham.
9118. Sewing Machines, F. N. Cookson, London.
9119. Culinary Beaters, P. Jensen.—(*W. A. McCowen, United States.*)
9120. Heeling Machines, T. H. Salmon and F. Jackson, London.
9121. Steam Boilers, P. Oriolle, London.
9122. White Lead, J. F. F. Lowe, London.
9123. Attachments for Looms, J. Tschörner and K. Wein, London.
9124. Fire Guard, H. Plunkett, London.
9125. Gun-carriages, R. C. Christie, M. Gledhill, and H. H. S. Carington.—(*J. Baptiste and G. A. Canet, France.*)
9126. Automatic Mica Stage, J. Edmonds, Hockley.

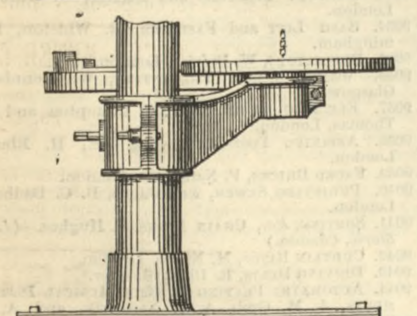
SELECTED AMERICAN PATENTS.

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

361,105. Drill Presses, *J. F. Winchell, Springfield.—Filed December 4th*, 1886.

Claim.—(1) In a drill press, the bracket for supporting the work tables, constructed with a plurality of arms and with a collar which fits the press column, in combination with a table for each arm. (2) A bracket for supporting the work tables of a drill press, constructed with a plurality of supporting arms and adapted to be connected with the press column.

361,105

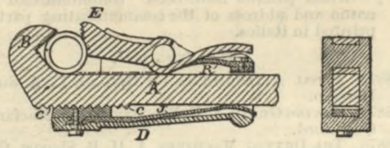


(3) A bracket for supporting the work tables of a drill press, constructed with a divided collar and with two supporting arms having divided ends, whereby the collar is adjusted to the columns and the arms to the table shafts. (4) In a drill press, the combination, with the column and the drill, of the bracket fitted to the column and having a plurality of supporting arms, and tables supported by said arms and adapted, respectively, to different kinds of work.

361,258. Pipe-wrench, *S. J. Benson, Washington, D.C.—Filed January 27th*, 1887.

Claim.—The lever A, having the fixed hooked jaw B and provided with serrations C on the opposite edge and the same end of the lever, in combination with the movable sleeve D, having midway between its

361,258

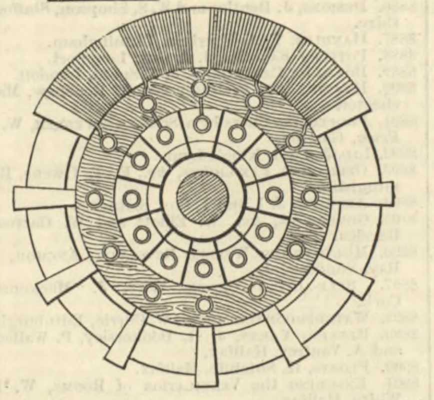


ends a fulcrum by which it vibrates upon the inner edge of the lever A, and carrying and inclosing the pivotted serrated jaw E, the springs R and J, and serrations G.

361,273. Fusible Connection for Armatures of Electric Generators, *J. W. Easton, New York, N.Y.—Filed April 13th*, 1886.

Claim.—(1) The combination, with the armature of a dynamo-electric generator, of a fusible connection between the joints of the armature coils and the commutator plates, substantially as described. (2) The combination, with the armature coils of an electric generator, of contact plates and fusible metallic conductors connecting the joints of said bobbins with

361,273

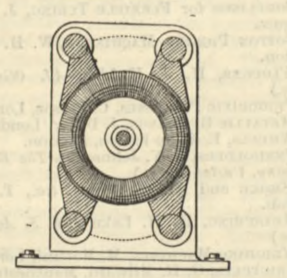


said plates. (3) The combination, in an electric generator, with a series of commutator plates and a series of bobbins, of a fusible metallic strip between each joint of each bobbin and each contact plate, and means for replacing any of said fusible strips, substantially as described.

361,274. Electric Motor, *J. W. Easton, New York, N.Y.—Filed July 3rd*, 1886.

Claim.—In an electric motor, the combination of an armature having polarised and neutral points, field magnets acting upon the polarised points, which field

361,274

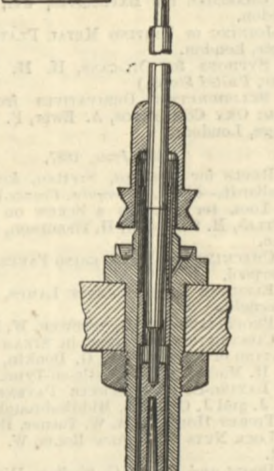


magnets have the central portions of their polar projections removed, and are thereby separated a greater or less distance from the neutral points of the armature substantially as described.

361,359. Spindle Support for Spinning Machines, *W. Hinchliffe, Nashville, Tenn.—Filed November 15th*, 1886.

Brief.—The bolster-case is provided with a bolster, which is held rigidly therein, the bolster being open

361,359

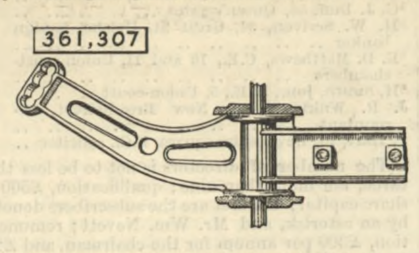


at its lower end; and below the bolster is a loosely-held step, which is restrained from rotation with the spindle, and is mounted upon a vertical pin.

361,307. Cultivator, *P. P. Mast, Springfield, Ohio.—Filed March 1st*, 1887.

Claim.—(1) The combination, with the cultivator beam or beam bracket having a hub provided with enlarged upper and lower ends, of a cross-head having an opening therethrough to receive said hub, and enlarged at the upper and lower ends of said opening to form bearing surfaces to match with the enlarged ends of said hub, and a bolt to connect the parts together. (2) The combination, with a cultivator beam or beam bracket having a hub whose upper and lower ends are enlarged to form flat bearing surfaces, of a cross-head having an opening therethrough to receive said hub, enlarged at the upper and lower ends of said opening and flattened at the enlarged portions, whereby the head is prevented from twisting with respect to the hub, and a bolt to pivotally connect the parts together. (3) The combination with a cultivator beam or beam bracket whose upper and lower ends are enlarged to form bearing surfaces, of a cross-head having an opening therethrough to receive the hub, enlarged at the upper and lower ends of the opening, the portions beyond the opening forming arms to which the shovel

361,307

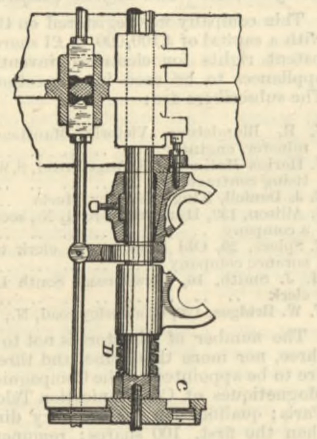


standards may be secured and one of them having a lug to which an alignment-rod is secured.

361,383. Roller Mill, *John Walker, Cleveland, Ohio.—Filed May 17th*, 1886.

Claim.—(1) In a roller grinding mill, the combination, with rods D, and boxes having sleeves mounted on said rods, one sleeve of each set of boxes having a recess therein, of a wedge-shaped saddle inserted in such recess between the upper wall thereof and the rod, and means for moving the saddle edgewise to adjust the sleeve vertically, substantially as set forth. (2) In a roller mill, the combination, with the rods D and boxes for the roller trunnions, said boxes having sleeves mounted on the rods D, of an adjusting screw connected with the inner box, a wedge-shaped saddle located between the rod D and box sleeve and provided with an upwardly-projecting ear adapted to engage a nut on the adjusting screw, substantially as set forth. (3) In a roller mill, the combination, with stationary and movable boxes, rollers mounted in said boxes, devices located between the boxes for moving the movable boxes away from the stationary boxes, rods connected to said devices, and a nut on each rod for holding the boxes in the desired adjustment, of the cam shaft having double-faced cams, the

361,383

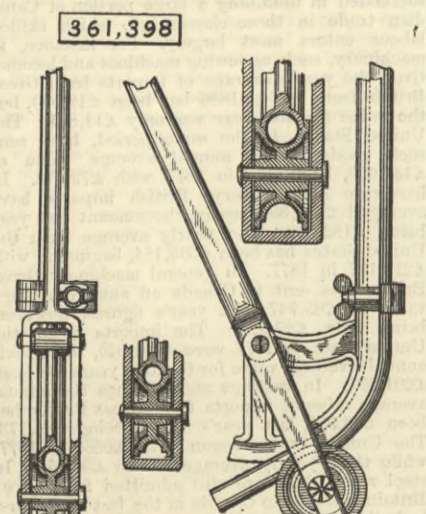


said cams being located between and in engagement with the adjacent ends of the rods, and operating substantially as described. (4) In a roller mill, the combination, with the movable and fixed rolls, mechanism for separating said rolls, and opposing rods connected with said separating mechanism, of a cam shaft having cams for actuating said rods, said cams being double-faced, and the one cam being arranged to operate in advance of the other cam when the shaft is moved in either direction, substantially as set forth. (5) In a roller mill, the combination, with a series of cam shafts, each having double-faced cams arranged on opposite sides to act one in advance of the other when moved in either direction, of rock arms connected with the respective cam shafts, links, removable pins connecting the links, and rock arms, whereby the cam shafts may be moved in unison, or by withdrawing a pivotal pin the disconnected cam shafts may be operated independent of the series of cam shafts, substantially as set forth. (6) The combination, with rods D and standard C, of the sleeve mounted on the rod and provided with a lateral shaft and a depending arm, an idle pulley journalled on the lateral shaft, and means for adjustably securing the depending arm to the adjacent standard C, substantially as set forth.

361,398. Device for Bending Pipe, *E. O. Daniels, Springfield, Ohio.—Filed January 10th*, 1887.

Claim.—(1) In a pipe-bending tool, the combination, with a former having a pipe seat whose cross section is semi-elliptical, and a portion whereof forms the arc of a circle, of a roller having a pipe-engaging groove whose cross section is also semi-elliptical, and which registers with the arc portion, and a lever carrying the roller and mounted to move it concentrically with that arc and cause it to engage and bend the pipe. (2) In a pipe-bending tool, the combination, with a bar curved at one end and having lugs, a pivotted clamping plate, and bolt and arms which form a fulcrum support, and a groove in one face thereof semi-ellip-

361,398

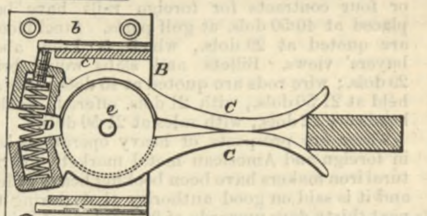


tical in cross section, of a lever pivotted in said fulcrum support and slotted at its shorter end, and an anti-friction roller mounted in said slot and against said arc and having a groove semi-elliptical in cross section. (3) In a pipe-bending tool, the combination, with a bar curved at one end and having lugs, a pivotted clamping plate and bolt, arms which form a fulcrum support, and a groove in one face thereof, of a lever pivotted in said fulcrum support and slotted at its shorter end and an anti-friction roller mounted in said slot and against said arc and having a groove in its periphery. (4) In a pipe-bending tool, a former having a groove semi-elliptical in cross section.

361,444. Picker Stick and Shuttle Cushioner for Looms, *J. H. Paige, Salida, Colo.—Filed August, 31st*, 1886.

Claim.—(1) In a combined picker stick and shuttle cushioner, the combination of the finger carrier B, the fingers C C, made flaring at their forward ends, the screw, pivot, or stud *e* and the adjustable spring D, and means for the adjustment of the latter, essentially

361,444

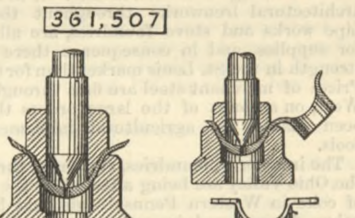


as herein described. (2) The finger carrier B, constructed in separate sections or parts *b c*, in combination with the spring-actuated fingers C C and the screw *e*, whereby said screw serves to form both a pivot to the fingers and to hold the sections of the finger carrier together, substantially as specified.

361,507. Method of Making Pipe Fittings, *J. T. Hambay, Pittsburg, Pa.—Filed January 28th*, 1886.

Claim.—(1) As an improvement in the art of manufacturing wrought iron or steel T's, crosses, and like fittings for pipes for the conveyance of fluids, the herein-described method, which consists in reinforcing a portion of a suitably-shaped blank, nozzling or flanging the reinforced portion, and then imparting the desired shape to the body portion of said blank, substantially

361,507

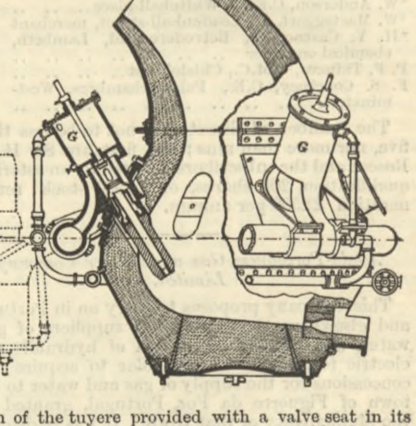


as set forth. (2) As an improvement in the art of manufacturing T's, crosses, and like fittings for pipes for the conveyance of fluid, the herein-described method, which consists in reinforcing a portion of the suitably-shaped blank, nozzling or flanging the blank at reinforced portion, imparting a circular form to the body portion of the blank, and finally welding together the adjacent edges of said blank, substantially as set forth.

361,624. Converter, *F. W. Gordon, Philadelphia, Pa.—Filed May 22nd*, 1885.

Claim.—The combination of a metallurgical vessel provided with a tuyere port, a plate having a central opening and secured to the exterior surface of the vessel and forming a margin to the port and a tuyere fitted to project into and through such port free of contact with the walls thereof and provided with a flange whose periphery seats in said opening. The combination of two or more tuyeres, a cylinder at each tuyere, outlets connected from the top of each cylinder and controlled by a single valve, and a piston in each cylinder attached to its appropriate tuyere, substantially as set forth. The combination of a metallurgical vessel, a tuyere fitted to reciprocate into and out of the metal in the vessel, and a valve in the blast-passage of the tuyere arranged to be opened and closed by the reciprocation of the tuyere, substantially as and for the purpose set forth. The combination of cylinders G and T, pistons S and U, connected by a hollow neck, port Z through the neck, and the tuyere attached to the pistons, substantially as set forth. The combina-

361,624



tion of the tuyere provided with a valve seat in its blast passage and a valve resting above said valve seat and adapted to reciprocate with the tuyere after the valve closes, substantially as set forth. The combination of a tuyere fitted to reciprocate and provided with a valve seat in its blast passage, a valve for such seat provided with a stem adapted to reciprocate through a support, and an adjustable collar on the stem and engaging the support, substantially as set forth. The combination, with a reciprocating tuyere and its operating cylinder, of piston S, connected to the tuyere by a hollow neck, valve seat *a*, stemmed valve *b*, supported by the piston and cylinder head, and collar *c*, substantially as set forth. The combination, with a reciprocating tuyere and its operating cylinder, of piston S, connected to the tuyere by a hollow neck, valve seat *a*, bushing *d*, stemmed valve *b*, and collar *c*, substantially as set forth. The combination, with a reciprocating tuyere and its operating cylinder and piston G S, of pin or screw *f*, substantially as and for the purpose set forth. The combination of a tuyere provided with an operating cylinder and mounted on trunnions, an outlet pipe K, a swivel M thereon, and a pipe L, leading from the tuyere cylinder to the swivel, substantially as set forth. The combination of a tuyere provided with an operating cylinder mounted on trunnions, an outlet pipe K, pipe swivel M thereon, and flexible pipe L, connecting the tuyere cylinder with the swivel, substantially as set forth.

Waste Bolts, Nuts, Rivets, and Washers.—In another page will be found part of a specification for wagon ironwork for Indian State Railways. In this it is stipulated that 20 per cent. additional bolts, rivets, and washers shall be included in the contract, to allow for waste. What becomes of all these?