THE DRAINAGE OF FENS AND LOW LANDS BY STEAM POWER.

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No. VIII.

THE turbine form of pump has a vertical spindle, and must be placed below the water, generally at the lowest level from which the water has to be pumped. The earlier forms were made with the fan divided into two parts with a centre diaphragm, but pumps of more recent construction have only a single fan with one inlet at the lower side of the disc. For the same quantity of water to be discharged this necessitates the fan being made of larger diameter than those having the double fan, and pumps with single fans can therefore be run at a smaller number of revolutions—a great advantage when used for drainage purposes. The water passes to the opening in this case through a trumpet-shaped mouth continued downwards a short distance to prevent the pump drawing air when the water is pumped to the lowest level. The gradually decreasing size of the opening at the entrance produces a corresponding increase in the velocity, which is again increased on leaving the fan by guide blades, the apertures between the guide blades being smaller near the fan than above.

The use of guide blades is found to increase very materially the discharging power of the pump. In experiments made by Mr. Parsons, a pump, which without the guide blades discharged 1500 gallons a minute, increased this quantity to 5000 gallons a minute when the guides were added, the pressure of steam remaining the same. This form of pump is fixed in an iron case or brick well, the outlet from which is at the lowest level to which the water in the outlet channel is ever likely to fall. No delivery or suction pipes are required, the opening in the well is either protected by a self-acting valve to prevent back flow when the pump is not working, or doors are placed at the end of the channel leading into the main outfall drain. The pump is hung by its spindle to a girder across the well at the top by a gun-metal bearing that is quite accessible, the spindle being stayed by horizontal guides in the well. No footstep is therefore required; the bearings of the different parts have conical seats, and the fan can at any time be taken out for repairs and replaced without emptying the water from the pump well. This arrangement secures the machine from the wear and tear due to its exposure to the grit and dirt contained in the water, and facilitates repairs when required. It is necessary to arrange the well or case so that it can at any time be pumped dry if required—a precaution, however, that is seldom wanted. This form of pump requires no valves, being always charged and ready for starting; being also covered by a considerable depth of water it is free from the action of frost, which is liable to freeze the water if left in a pump exposed to its action, and burst the case. The friction of the water along the suction and delivery pipes necessary in the other form of pump are also avoided.

The action of a centrifugal pump is as follows:—As soon as the fan begins to revolve the blades carry the water with them, which is then pushed forward and drawn into the case partly by the mechanical action of the blade propelling the water forward, and partly by the centrifugal action created by the rapid rotary motion created by the fan. The vacuum created by the water driven out by the fan is immediately filled by a fresh supply of water from the inlet. The water driven out by the fan is propelled along the discharge pipe, or having no other means of escape, rises up the pump well till the outlet is reached. A constant and continuous stream without check or shock, as in bucket pumps, is thus created, and the water is kept in motion along its whole passage. The quantity of water discharged is as the square of the diameter of the fan, and not in proportion to its cubical contents, the speed at the periphery and the lift being the same.

The best velocity for the water to flow through the passages of the fan is from 6ft. to 8ft. per second. The discharge increases with the increase of velocity, a small increase in the number of revolutions producing a large increase in the delivery. Mr. Parsons—"Trans." I.C.E., vol. xlvii.—states that he found an increase of fourteen revolutions—392 to 406, or about 3½ per cent.—increased the discharge from 1012 gallons to 1753—42 per cent. Up to a certain speed the pump does not act, and the fan revolves without lifting the water over the overflow. Unless the speed for which the pump is intended to be run at is attained, the machine does not work efficiently at its best, and fuel is wasted. It is important therefore that the engineman in charge should know the velocity for which his pump is speeded. The formulas for ascertaining the quantity of water discharged by a centrifugal pump are complicated, and the coefficients vary with each particular make. Messrs. Easton and Anderson furnish the purchasers of their drainage pumps with a diagram by which the quantity discharged can be ascertained by inspection when the lift and speed are known. If a record is kept of the lift, and the speed and time of working of the engines by the engine-driver, checked by locked counters attached to the machinery giving the number of revolutions, a means is provided of preserving a record of the quantity of water pumped, and at the same time a check is placed on the engine-driver.

In the centrifugal, as in all other pumps, a certain amount of the power applied in driving them is absorbed by friction of the bearings and resistance due to roughness of the surface of the pump, and the eddying motion of the water; this loss varies from 30 to 50 per cent. The duty to be expected from a centrifugal pump of the best construction used for drainage purposes may be taken at about 75 per cent., falling in small-sized pumps and those not of the best construction to 50 per cent. The ratio of useful effect in water lifted, as compared with the indicated horse-power, for the direct-acting pumps put up by Messrs. J. and H. Gwynne, has been found to vary from 55 to 60 per cent. This also includes the work of the engine.

The statical height of water which these pumps will support without discharging requires a speed which varies in some degree with the form of the blades. Mr. Thompson—"Trans." I.C.E., vol. xxxii.—states, as the result of his experience, that the speed of the periphery per second required to balance the weight of the water up to the point of discharge is equal to eight times the square root of the given height in small pumps and 9·82 times in large pumps. In a letter which appeared in THE ENGINEER of September 24th, 1886, Mr. C. Brown gives, as the result of experiments made by him with

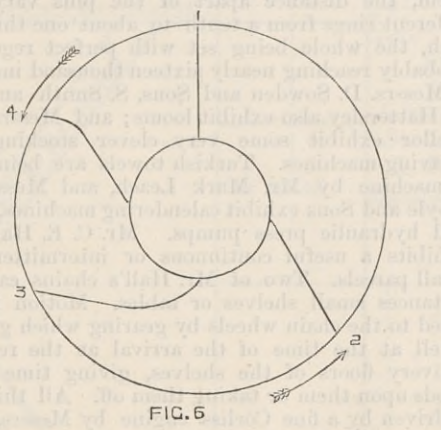


FIG. 6

pumps having blades of the form shown in Fig. 6—the water being held at a height of 45ft.—

(1) Required a speed per second = $\sqrt{2gh}$.
(2) " = considerably more.
(3) " still more.
(4) " $0·82 \times \sqrt{2gh}$.

In a description of the pump made by Mr. C. Hett, of Brigg, for the s.s. Eldorado, in THE ENGINEER of June 18th, 1886, it is stated that Mr. Hett found a pump of his make with 2ft. disc which gave a full discharge at a height of 16ft. 6in. when running 190 revolutions a minute, the velocity at the periphery being only about two-thirds of the head due to gravity. The following formula for ascertaining the speed and discharge—founded on Mr. Thompson's data—is given in Molesworth's "Engineering Pocket Book":—

$S = 8\sqrt{H}$ in small fans, or $9·5\sqrt{H}$ in large fans.

$H = \frac{S^2}{64}$ " or $\frac{S^2}{90·25}$ " "

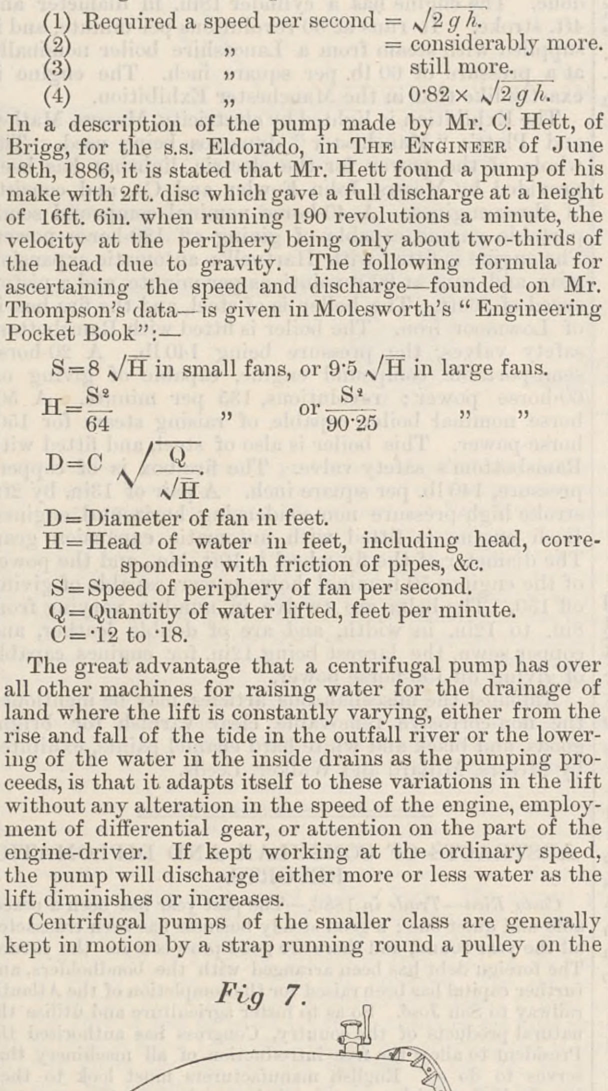
$$D = C\sqrt{\frac{Q}{\sqrt{H}}}.$$

D = Diameter of fan in feet.
H = Head of water in feet, including head, corresponding with friction of pipes, &c.
S = Speed of periphery of fan per second.
Q = Quantity of water lifted, feet per minute.
C = ·12 to ·18.

The great advantage that a centrifugal pump has over all other machines for raising water for the drainage of land where the lift is constantly varying, either from the rise and fall of the tide in the outfall river or the lowering of the water in the inside drains as the pumping proceeds, is that it adapts itself to these variations in the lift without any alteration in the speed of the engine, employment of differential gear, or attention on the part of the engine-driver. If kept working at the ordinary speed, the pump will discharge either more or less water as the lift diminishes or increases.

Centrifugal pumps of the smaller class are generally kept in motion by a strap running round a pulley on the

Fig 7.



spindle of the pump and the driving wheel of the engine Those of the turbine form are worked by a mitre pinion, keyed on to the vertical spindle gearing into a bevel wheel on the crank shaft of the engine. Direct-acting engines and centrifugal pumps are also constructed with engine and pump on the same base plate, the piston-rod being attached by a short connecting-rod to a crank in the spindle of the pump. In Fig. 7 is shown one of these pumps as fitted up by Messrs. J. and H. Gwynne for the drainage of the Grootslag Polder, near Andyk, the lift being 10ft. 6in. and the discharge 75 tons per minute for each pump.

Messrs. Gwynne strongly advocate the use of the pump with horizontal spindle as preferable to the turbine type, being, in their opinion, more effective, occupying only a very small space, and requiring inexpensive foundations, the cost of the instalment being considerably less than that of any other type.—"Notes on Pumping Machinery for Drainage Purposes," by J. and H. Gwynne, 1885.

Messrs. J. and H. Gwynne have erected several of these direct-acting engines and pumps in Holland and France, particulars of some of which will follow. For the drainage of the Middel Polder in Holland, containing 1600 acres, a pair of their engines and pumps were erected in 1878. The space occupied by engines and pumps is only 21ft. by 11ft., and they are each capable of delivering 30 tons a minute to a height of 16ft. Although these engines make 138 strokes a minute, and, when emptying the lake, worked for three months, night and day, they have run for eight years without anything being required to be done to them except ordinary repairs. At the Legmeer Polder a pair of direct-acting vertical engines and pumps were also erected by the same firm in 1875. Each engine and pump is capable of lifting 75 tons 17·38ft. per minute, and occupies a space 15ft. by 10ft. These engines make 156 revolutions a minute; yet, notwithstanding this high speed, the author was assured by the superintendent in charge that, beyond an accident to the fan of one of the pumps, owing to a piece of wood having got into the case, no stoppage had taken place, and the repairs had only been slight and of the ordinary character common to all machinery. The satisfactory working of this class of pump was confirmed at other stations in Holland which the author visited. The small space occupied by this class of machinery, and the fact of the pump being placed on the same floor with the engine, is the means of effecting considerable saving in foundations. In the case of the pumps at Middel Polder, a road intervenes between the engine-house and the river into which the drainage water is discharged; the iron delivery pipes are carried beneath this road, the usual masonry culvert under the road being thus dispensed with.

The theory relating to the force and discharge of these pumps, with the result of experiments in connection therewith, will be found in the papers in the "Transactions" of the Institution of Civil Engineers, by Mr. Thompson, in 1871, vol. xxxii.; Mr. Parsons, in 1876, vol. xlvii.; Mr. Unwin, in 1877, vol. liii.

With the best class of pumps with low lifts, such as are required for drainage purposes, the following may be taken approximately as the rate of discharge. The amounts given are, however, considerably above those attained by the pumps in ordinary use:—

Diameter of suction and discharge pipe, in inches.	Water discharged per minute. Gallons.	Tons.
15	5,000	22·32
18	7,000	31·25
24	11,000	49·10
30	18,000	80·35
36	20,000	89·28
42	27,000	120·53
48	40,000	178·57
54	70,000	312·50
60	100,000	446·43

THE SALTAIRE EXHIBITION.

AMONGST the processes of manufacture exhibited in the Saltaire Exhibition there are match, pencil, and pin making, none of which have been shown to the public in these modern successors of the old fairs. All these are interesting to the visitors, as illustrative of the manufacture of articles of common use, and made by very simple appliances, at least as far as the two first mentioned are concerned. The match making is exhibited by Messrs. Seanor and Sons, and illustrates the ordinary method in which the wood is cut up in guillotine machines, and the splints, long enough to make two matches, placed, by hand, in dipping frames, one end projecting on either side of the frame. After being dipped in paraffin, and in the igniting mixture, they are dried and cut in two and packed. The dipping is not actually shown at Saltaire, as this, and the cutting after drying, are both, if not dangerous, at least risky operations, and such as could not be permitted in an exhibition building. Match making machinery made under Norris's patent is not exhibited; but this system of manufacture is interesting, as it makes the splints of the proper length from the first, and the work of putting them into frames for dipping and drying is performed automatically.

The manufacture of pins at the rate of 160 per minute is carried on by one small machine, one tumbling barrel, and some apparatus in which they are whitened. The machine bears some resemblance to the French nail-making machines, but it differs materially in two essentials—namely, in that the blank wire is thrice gripped in making the head, and in the pointing apparatus employed. It takes rather more than an eighth of an inch of the pin wire to make a pin head. If the attempt were made to upset this length of wire, and form it into a head in one operation—that is, with one grip and one squeeze by the snap-head die—the wire would rather double up than thicken up in almost all cases. The wire is therefore first gripped with about a twentieth of an inch projecting. This is squeezed up or upset, so that it is reduced to about one-thirtieth of an inch. The grippers then release it, and it is pushed forward another twentieth of an inch, and this is similarly reduced. When this is repeated a third time, sufficient wire has been upset to form the head, and it is finished and the wire cut off to the required length. The headed blanks fall into a receptacle, whence they arrange themselves in order in the narrow slot between two inclined and bevel-edged bars, shown in section at A A, Fig. 1. It is a matter of no importance how the blanks P fall, as they must find the position shown. The slight jarring of the machine is sufficient to cause the blanks to descend the bars A, and at the lower end they are caught between a fixed part of the machine C, and a piece D which has a longitudinal reciprocation of short range combined with a movement which separates D slightly from C, so that the blanks P gradually pass along in the direction of the arrow. Below D revolves at a high speed a cylindrical cutter about 9in. in length. This cutter is made in a peculiar manner, and may be called a cylindrical file. It consists of cylindrical segments E, made from sheet steel, grooved with fine, sharp grooves like a single cut file. This steel is cut up into lengths and bent round into the cylindrical form E—see Figs. 2, 3, and 4—and hardened. The ends of the cylindrical segments are

FIG 1

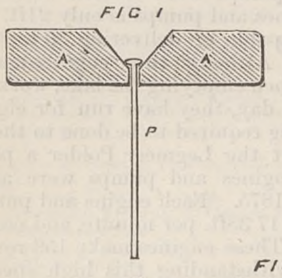


FIG. 4

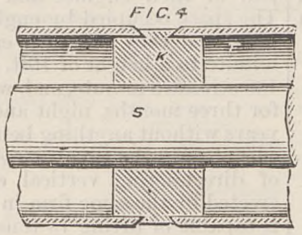


FIG 3

bevelled, as seen in Fig. 4, and held at the ends by collars that catch their edges, and by intermediate collars K on the spindles S—Figs. 4 and 3—that catch them and hold them firmly. The ends of the blanks P are very lightly pressed by this fine rotary file, but with the high speed at which the file runs more pressure than the elastic spring of the wire is unnecessary, and by the time they reach the end of the guide pieces C D, they are well and finely pointed. The mode of making up this cylindrical cutter is ingenious and such a tool might have many applications. The

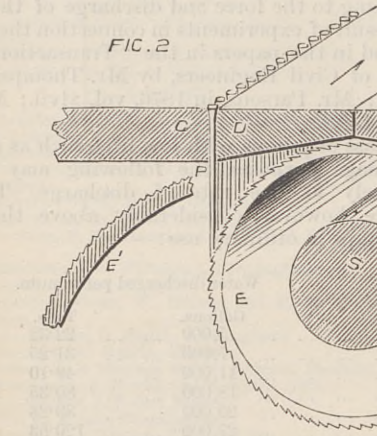
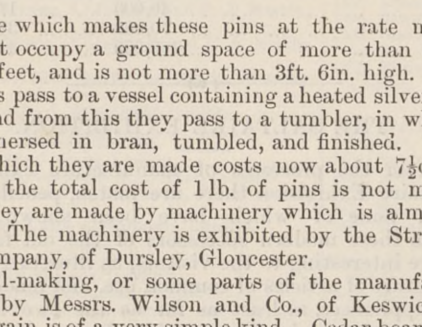


FIG. 2

machine which makes these pins at the rate mentioned does not occupy a ground space of more than about 2½ square feet, and is not more than 3ft. 6in. high. From it the pins pass to a vessel containing a heated silvering mixture, and from this they pass to a tumbler, in which they are immersed in bran, tumbled, and finished. The wire from which they are made costs now about 7½d. per lb., so that the total cost of 1 lb. of pins is not much now that they are made by machinery which is almost automatic. The machinery is exhibited by the Stroudwater Pin Company, of Dursley, Gloucester.

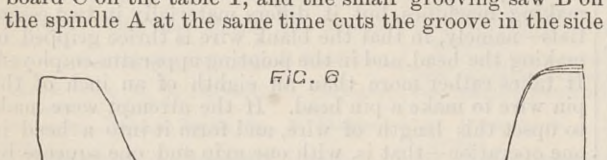
Pencil-making, or some parts of the manufacture, is shown by Messrs. Wilson and Co., of Keswick. This plant again is of a very simple kind. Cedar boards, C, are cut up into slips, which are at the same time grooved on one side. The sketch, Fig. 5, indicates the saw bench on which this is done. The cedar board to be cut up into

FIG. 5



strips P is guided by the guide G and pushed past the saw S mounted on a spindle D. This cuts the strip from the board C on the table T, and the small grooving saw B on the spindle A at the same time cuts the groove in the side

FIG. 6



of the slip. The leads, most of which are moulded from pulverised foreign blacklead, are laid with glue in the groove, and a strip without the groove is glued over it. After drying, the rough square pencil is passed through a well-known form of rapidly-revolving inside or hollow cutter, which leaves them round and smooth, according to the condition of the cutter. After this they are sand-papered by boys, and some are polished. They are usually made two pencils in one length, afterwards cut into two. Comparatively few pencils are made now with the leads cut from the pure Cumberland lead, and few lumps of this native lead will give a piece more than 2in. to 3in. in length, so that the groove of a pencil made with it is filled up with short pieces.

Amongst the machine tools exhibited is a very useful lathe with a small planing attachment exhibited by Mr. J. Appleyard. Messrs. Taylor, Wordsworth, and Co. show a fine collection of Noble's wool-combing and finishing machines, and Mr. John Perry shows a fine piece of work in a Noble's ring comb for one of these machines. It is a gun-metal ring about 3ft. 9in. diameter, with six annular rings of pointed pins set into holes drilled for them, the distance apart of the pins varying in the different rings from a tenth to about one-thirtieth of an inch, the whole being set with perfect regularity, and probably reaching nearly sixteen thousand insertions.

Messrs. D. Sowden and Sons, S. Smith and Sons, and G. Hattersley also exhibit looms; and Messrs. Moss and Mellor exhibit some very clever stocking net cloth weaving machines. Turkish towels are being woven by a machine by Mr. Mark Leach, and Messrs. Elkanah Hoyle and Sons exhibit calendering machines, hot presses, and hydraulic press pumps. Mr. C. E. Hall, Sheffield, exhibits a useful continuous or intermittent hoist for small parcels. Two of Mr. Hall's chains carry at equal distances small shelves or tables. Motion is communicated to the chain wheels by gearing which gives a slight dwell at the time of the arrival at the receiving and delivery floors of the shelves, giving time for placing goods upon them or taking them off. All this machinery is driven by a fine Corliss engine by Messrs. Hick, Hargreaves, and Co., from which the accompanying engraving was taken, when only a small quantity of work was being done. The engine has a cylinder 18in. in diameter and 4ft. stroke. It runs at 60 revolutions per minute, and is supplied with steam from a Lancashire boiler nominally at a pressure of 60 lb. per square inch. The engine is exactly like that in the Manchester Exhibition.

The Exhibition is lighted by electricity, Messrs. Mather and Platt's "Manchester" dynamos being used. The whole of the power for the electric lighting has been provided by Messrs. John Fowler and Co., and consists of three engines. A 40-horse nominal compound semi-portable engine, capable of giving off 120-horse power. The engine is fitted with Hartnell's automatic expansion gear, and runs at 90 revolutions per minute, and a piston speed of 360ft. The boiler is of steel, and the fire-box is of Lowmoor iron. The boiler is fitted with Ramsbottom safety valves, the pressure being 140 lb. A 20-horse semi-portable compound engine, capable of giving off 60-horse power; revolutions, 135 per minute. A 50-horse nominal boiler, capable of raising steam for 150-horse-power. This boiler is also of steel, and fitted with Ramsbottom's safety valve. The fire-box is of copper; pressure, 140 lb. per square inch. A pair of 13in. by 2ft. stroke high-pressure non-condensing horizontal engines. Each engine is fitted with automatic expansion gear. The diameter of the fly-wheel is 10ft. 5in., and the power of the engines 50 nominal horse-power, capable of giving off 150. The belts are twelve in number, varying from 8in. to 12in. in width, and are of double leather, and copper sewn, the largest being 12in. for engines capable of giving off 150-horse power.

Amongst the miscellaneous articles may be mentioned the non-corrosive removable clear varnish for bright goods, and black and white hard enamel paints, exhibited by Messrs. Millard and Walker, Leeds.

ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS.

Costa Rica—Trade in 1886.—The past year has been a peaceable and quiet one; a good steady business has been transacted all the year round, and there are good prospects for the future. The foreign debt has been arranged with the bondholders, and further capital has been raised for the completion of the Atlantic railway to San José. So as to foster agriculture and utilise the natural products of the country, Congress has authorised the President to allow the free introduction of all machinery that serves to do so. English manufacturers must look to their laurels, if they wish to retain their position, as Germany and the United States are fast becoming competitors in these markets, and producing goods as cheap and equal in quality, if not superior, to those of Birmingham. In the capital, San José, where there is a large business done, there are among the chief merchants and shopkeepers three American, two Colombian, one Danish, three French, five German, and three Spanish houses, but not one English house. English hardware has been superseded by the manufactures of Germany and the United States.

France—Trade of Marseilles in 1886.—With the exception of the French vessels which have a monopoly of the coasting trade, England holds the first place in point of tonnage, and as compared with 1885 there is an increase of seventeen vessels and 24,160 tons. Freights, hence, have been very scarce, and the greater portion of our vessels sailed from Marseilles in ballast, generally for the Black Sea and Spanish ports, seeking cargoes. The British coal trade shows a large increase in imports compared with 1885. The increase is almost entirely in South Wales coal, and arises from low prices of coals at home and exceptionally low rates of freight during the year, thus enabling merchants to compete with French collieries, both for town and manufacturing trades and the requirements of the French liners, &c. The demand for Newcastle coal is almost nominal, the only importation being confined to the requirements of the Marseilles gas works. Notwithstanding the operation of the bounty system, the shipbuilding in this district is in a languishing condition, and at one of the principal yards the proprietors have been forced to discharge a considerable number of hands, though some reduction in their numbers had taken place in 1885.

France—Production of coal, iron, and steel.—Of anthracite and coal the yield was 19½ million tons in 1886, against 19 million tons in 1885. One-third of the quantity raised was from the collieries of the Pas de Calais, one-sixth from those of the Nord. The yield next in importance is that of the Loire, then come those of the Drôme and Saone et Loire. The pig iron produced in 1886 was 1,507,850 tons, against 1,630,648 tons in 1885. The pig smelted by charcoal fell from 29,000 tons in 1885 to 13,000 tons in 1886. Manufactured iron was 767,214 tons in 1886, against 782,431 tons in 1885. Of this, rails fell from 4479 tons in 1885 to 910 tons in 1886. Iron has almost ceased to be used for the permanent way of railways. The production of steel fell from 553,839 tons in 1885 to 466,913 tons in 1886. Out of this the quantities of rails turned out in 1885 and 1886 were 355,558 and 252,933 tons respectively. The department of the Nord turns out half the total supply required by France in the shape of manufactured iron. For steel there is an active and equal competition between the Nord and the Meurthe et Moselle.

France—Trade of Boulogne district in 1886.—There is a slight falling off in the import of coal. Pig iron shows a very marked decrease, and it seems as though the imports of this material would gradually cease; the quantity imported through Calais decreases, but not to the same extent. Iron ore which is imported from Bilbao shows a further large decrease. There is a fall in the quantity of machines and machinery from England; owing to the heavy Customs duty it is difficult for British manufacturers to compete with French, and were it not for the superiority of English machines the decrease would be greater. Practical men assert that owing to certain English firms giving special attention to a certain class of machines and making them a speciality, they are able to produce them of a sufficiently superior quality to make up for the increased cost caused by the heavy duty, and that they can in some cases compete with the cheaper machines made abroad. At Calais the falling off in the imports of coal has ceased, and there is an increase, but the quantity is below what it was a few years ago. The decrease in the quantity of pig iron arriving from Great Britain continues; it is now about half what it averaged a few years ago. There is a further decrease in the imports of machinery from England, owing to the stagnation in the lace trade of Calais. At Dunkirk the importation of pig iron has considerably diminished, and it is very probable that it will never rise again to its old figures, owing to the increased production of France. In 1886 246 tons of Belgian girders were shipped from this port to the United Kingdom; this was probably owing to the merely nominal freight paid, though the girders must have been cheaper than British ones. Of the three blast furnaces at Outrean—a suburb of Boulogne—only one is in blast. The blast furnaces at Marquise have been out for two years, and the large ironworks which employed over 3000 people are nearly closed. The supply of iron ore for the blast furnace at Outrean and the steel works at Isberquis is obtained almost entirely from Bilbao, arriving generally in French bottoms. The following table gives the production of the iron-works of the Nord for 1884 and 1885:—

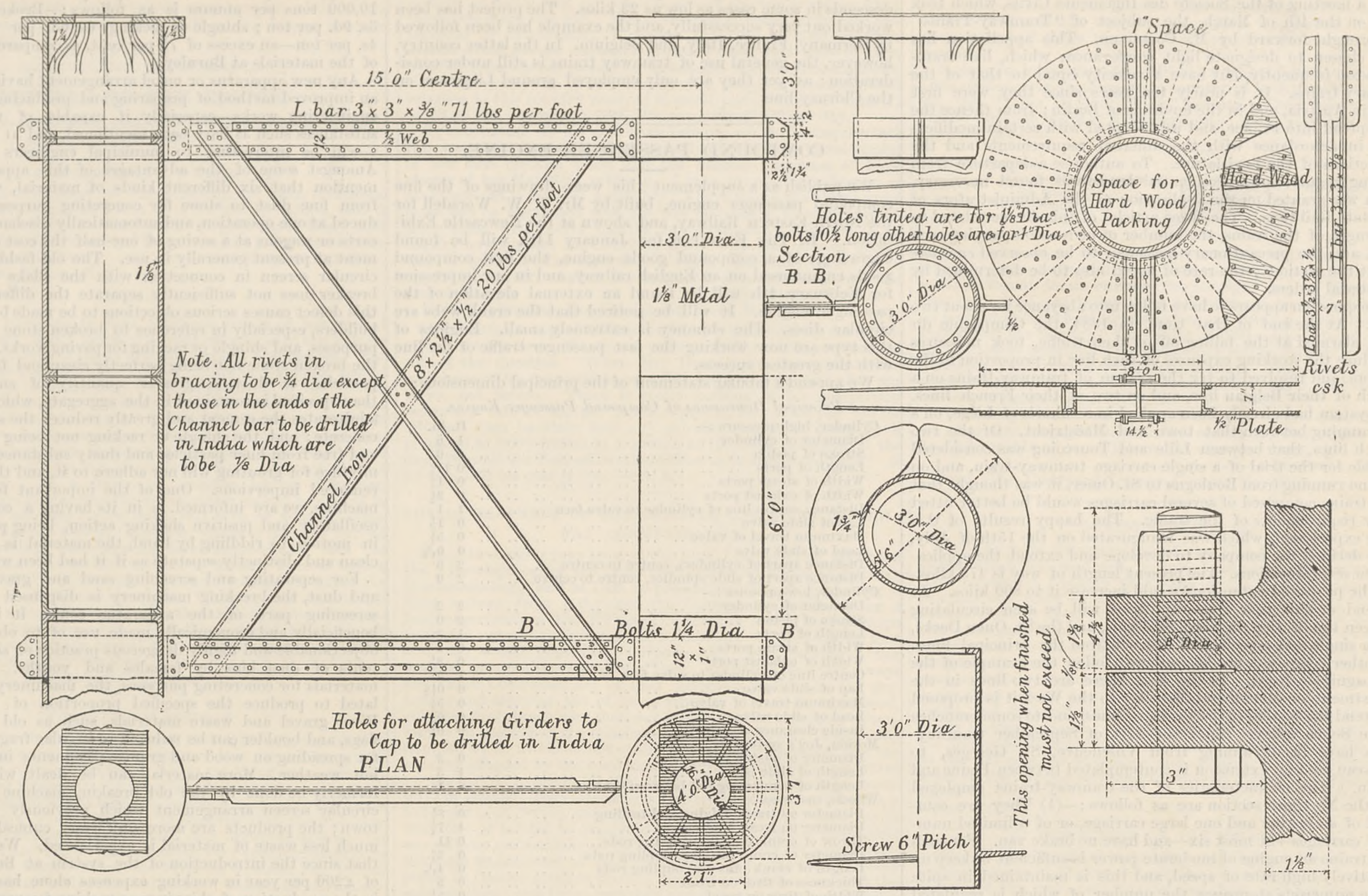
Nature of product.	1884.	1885.	1882.	1884.	1885.
	Quantity in tons.	Quantity in tons.	Price.	Price.	Price.
			£ s. d.	£ s. d.	£ s. d.
Bessemer steel ..	75,377	83,817	7 16 0	7 3 10	6 8 9
Merchant iron ..	208,709	196,905	7 10 4	6 4 4	5 6 3
Rails	12,944	2,804	7 18 6	6 10 0	5 8 4
Refined iron	216,030	214,113	3 0 11	2 9 7	1 18 0
Sheet iron	20,237	40,092	10 19 5	7 11 11	6 6 1
Special iron	46,579	24,602	7 7 4	6 0 4	5 2 0

Sheet iron has nearly doubled, while all other kinds have fallen off. Bessemer steel shows an increase, but the quantity produced is still below that of 1883. The prices in the above table for 1882 show the great fall that has taken place in the price of iron. It seems difficult to exaggerate the depressed state of the iron trade in the North of France. The zincworks at D'Auby-lez-Douai in 1885 produced 10,600 tons, which was about the average quantity; the average price was £14 14s. 10d. per ton, a fall of 9s. 10d. per ton on the price of the preceding year. During the year 1885, notwithstanding the commercial depression, there was an increase in the quantity of coal raised in the Pas de Calais; this is accounted for by the reduction in the sale price having enabled the coal to be sent to greater distances and compete with foreign coal. Thus, in spite of a greatly diminutive consumption, these collieries have been enabled to increase their output. The quantity raised in 1886 was about 6,350,618 tons, which shows a progressive increase, though the mine at Hardinghen was not worked. In 1885 these mines employed 28,581 hands; the total sum paid to the workmen was £1,271,942; the average daily pay to each workman was 3s. 2d. for those underground, and 2s. 7d. to those above ground.

Spain.—Trade of Malaga in 1886.—Though there has been a decline in the number of ships and amount of tonnage, the British carrying trade has not suffered any material loss, whilst at the outports in the consular district British shipping has increased both in number and tonnage, especially at Carthagena. A chamber of commerce has been formed, and in addition to its members, captains of vessels of every nationality, foreign merchants, shipowners, and tradesmen established in the city may bring their suits before the chamber; but all parties to the arbitration must previously agree to be bound by the decision of the jury, formed by ballot from the committee to hear the case, against which decision there is no appeal unless the jury disagrees, when the chamber may name a new jury composed of a greater number of persons. Foreign merchants who have been established in the country ten years, and who have paid taxes according to their position, may become members of the chamber, and enjoy the same rights and privileges as natives. The commercial convention between Great Britain and Spain has not yet materially affected the trade of the district. Something more than mere reduction in tariff of British goods is still wanting to bring back from Belgian, French, and German competitors the trade which they were able to divert from us during the many years' existence of the differential tariffs. Unless our manufacturers employ commercial travellers acquainted with the language of the country, and qualified to study the requirements of their customers, they can hardly regain the ground that has been lost. There are at Malaga a number of young German clerks who on their return home will be prepared by knowledge of Spanish for employment by German firms having business with this country. Some such system might be advantageously adopted at home. British goods coming to this market, though of better quality than foreign manufactures of the same class, are usually considered too expensive, and the dealers are often forced to fall back on the cheaper wares of other countries.

Italy—Trade of the district of Genoa for 1886.—In English trade shipping has again increased over all previous years, but the increase is due only to the large imports of coal. In all other goods the import from England has declined. "I am not at all sanguine as to the extension of our trade with this country in the branches which were formerly of most importance. With India trade is likely to increase considerably, but not with England. In the metal trades, though pig iron and tin-plates still come entirely from England, brass and iron sheets are arriving largely from Belgium and Germany; and in machinery, the native industry has of late made rapid strides towards emancipating itself entirely from foreign competition by means of arrangements with English and French firms of old standing and great experience bringing in their capital and technical knowledge to the assistance of the native establishments, which

BURMA STATE RAILWAYS.—BRIDGE PIER WORK, MANDALAY EXTENSION.



are further enormously protected by the patronage of Government, which now in all contracts specifies that native firms are to have preference over foreigners, even where competition is nominally open to all comers. During the past two or three years the tendency has been for English firms to join the native industries and share their profits, instead of competing against them, as in the case of Messrs. Maudslay's alliance with Ansaldo and Co., of Sampierdarena; Messrs. Brotherhood, with Odero and Co., of Sestri, Messrs. Hawthorn, with Guppy and Co., of Naples; and Messrs. Armstrong and Co.'s establishment at Pozzuoli. Again, Messrs. Henfrey and Co., of Pertusola, have enlarged their smelting establishment at Spezzia, and have annexed to it a shipbuilding yard and machinery shops, at which they are constructing boilers, engines, and steam vessels, to profit by the Bounty Act passed last year in favour of the Italian Mercantile Marine. If Englishmen did not thus come forward, Germans, French, or Swiss would; and one of the big undertakings, the new rolling mills at Leghorn, is the creation of a French firm, who set them up as an Italian limited liability company with the special object of taking Government contracts. Ansaldo and Co., of Sampierdarena, have on hand for the Government alone work which involves a large extension of their old premises, besides the opening of a new building yard at Sestri Ponente. They have at this new yard a 100-ton floating crane, a despatch boat, and eight torpedo boats, and at the old establishment they have, besides a quantity of torpedo boat engines and locomotive engines, some very important forgings for Government, and the engines and boilers for the 20,000-horse power Sicilia, one of the three great ironclads the Italian Government have decided to build, the other two being constructed at Leghorn and Naples. Odero and Co., of Sestri, are also actively employed in making engines; Wilson, Maclaren, and Co., of Rivarolo, have also been fully employed; and Cravero and Co., of Genoa, have built a small steamer for the Roman trade, and have on hand four torpedo boats for the Government. Tardy, Benecke, and Co., of Savona, have entered into an alliance with a Westphalian firm, of Bochum, who are to put a considerable capital into these works, which are to be immediately enlarged, with a view of undertaking the manufacture of cannon, iron plating, and other war material. The ironworks of this neighbourhood are therefore fully employed. The import of pig iron has still further fallen from the small amount of 1885, and the import of old and broken iron has also fallen off, the probability being that there were large stocks of old Government stores and railway iron available. Manufactures of cast and wrought iron have slightly increased, while machinery has fallen off. A deal of the import classed as wrought iron consists of parts of machinery imported by the local firms to be fitted in their workships. There has been some increase in the import of galvanised wire rope from England, which trade seemed to be passing into the hands of the Germans, but has of late revived. In corrugated iron and other sheeting for roofs we have also made a stand against German competitors, and tinplates are still exclusively supplied from England. The quantity imported in 1886 was about double that in 1885. In steel we continue to hold our own. In brass bars and sheets, copper and yellow metal, we are doing very little, and shall probably be shut out of the market altogether when the new works at Leghorn—which are to open this year—have got into full swing. The imports of British coal have again increased, and last year amounted to 1,074,000 tons. Of this amount 542,600 tons were from Cardiff, 439,500 tons from Newcastle, the remainder being North English and Scotch coal shipped at Liverpool. The import of British coal to Savona has also increased, which shows that the competition of German coal through the St. Gothard has not made itself felt in this part of Italy, nor has the bounty of 9·6d. per ton granted to Italian vessels had any sensible effect on our trade, almost all this large import having been under the British flag.

United States—Trade of Galveston in 1886.—Galveston is still doing a steady business, and the State of Texas extending and improving its business relations with Europe, though the strangling of imports by protective and prohibitive duties continues. The average duty now imposed on European imports is an *ad valorem* of nearly 50 per cent. A New York merchant who buys £20 worth of British goods must pay in addition nearly £10 to the New York Custom-house. The Texan wholesale dealer will have to pay £30 plus the New York merchant's profits, so that before the goods reach the consumer they will have cost at least £34 to £35. It is complained that the present tariff not only deprives the Southern American consumer of a cheap purchasing market, but enables the Northern manufacturers to combine and fix exorbitant prices just below the cost of imports. The protected steel manufacturers are said to have realised during the past year 67 per cent. profit on their united capital of £4,375,000. The price of steel rails in America is from £7 1s. 8d. to £7 5s. 10d. per ton. In England the price is £3 17s. 1d., and the import duty is £3 10s. 10d. per ton. If there was no duty £5 4s. 2d. would pay for imported English rails for New York. The protected American manufacturers having turned out and sold 1,700,000 tons of rails in 1886, have pocketed a bonus of £3,540,000 clear and above the natural cost of English rails landed in New York. The natural price of English rails in New York, less duty, being £5 4s. 2d. a ton, the British manufacturer, even if rails were free, would be handicapped by a natural protective duty of £1 7s. 1d. per ton in favour of the American rail producer. The amount of wages paid by the combined American ironmasters to their men for 1886 is said to be £1,416,667. Assuming the total output to be at or about 1,700,000 tons, the cost of production is therefore under 12s. 6d. per ton, but call it 14s. 7d., in which case the natural protection of £1 7s. 1d. per ton cost of transport would pay the wages, and leave a profit of 12s. 6d. per ton, which on 1,700,000 tons would be £1,062,500. According to the American manufacturers' statement, the total cost of the raw material and wages was £8,720,390, the total value produced was £11,628,669, leaving a profit of £2,908,279.

BURMA STATE RAILWAYS.

THE drawings above illustrate the ironwork now about to be constructed under contract for bridge piers on the Toungoo and Mandalay Extension of the Burma State Railways, metre gauge. The ironwork comprises fifteen bridge piers, consisting of cast iron cylinders, 3ft. in diameter, caps, screw lengths, and wrought iron bracings, &c.; one capstan head for sinking piers; five spare cylinders, intermediate lengths; one spare cylinder, screw length. All the rivets and bolts required to complete the erection of the piers in India had to be supplied with an allowance of 50 per cent. on the net quantity of rivets required for waste.

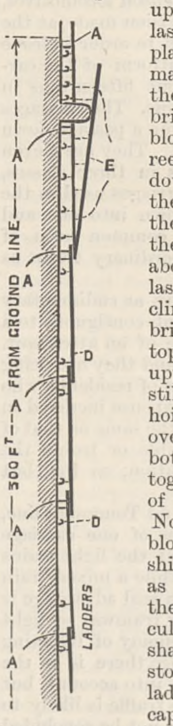
The columns for these bridge piers are, it will be seen, strong plain cylinders, the flanges being inside, and of the section shown to a larger scale in the upper part of the engraving above. It will be observed that lugs for bracing purposes are not cast upon the columns or piles, but strong wrought iron bracing clips are employed to avoid any of the dangers resulting from the failure of a lug. Our engravings also show the capstan head which is to be used for sinking the screw piles.

LADDERING A TALL CHIMNEY.

FIFTY years ago Messrs. P. Dixon and Sons, of Shaddongate Cotton Mills, Carlisle, built a tall chimney shaft, which is a landmark for miles around, in connection with their factory. This shaft is described in Bancroft's treatise on "Tall Chimney Construction" as being of the following dimensions:—Height from foundation to top, 320ft. 6in., and from ground line, 300ft.; outside measurement at ground line, 17ft. 4in., and inside measurement, 9ft. 6in.; outside dimension at top, 9ft., and inside at top, 6ft. 8in.; built to a batter of 1 in 72. Being the fiftieth year of this tall shaft, Mr. Robert Todd, woollen manufacturer and present occupier, is having it repaired, and a new copper rope lightning conductor fixed up the outside. Mr. Joseph Ball, known as a chimney and spire restorer and lightning conductor fixer, of York Castle, Oldham is doing the work.

In carrying out this difficult undertaking, the ascent to the top of the shaft has been made by fifteen wooden ladders of the ordinary type, as used by painters, specially made light and strong for the purpose, and weighing from 20 lb. to 50 lb. each according to their length, and of the average width of 11½in. at bottom, and tapered to about 10in. at top. Distance pieces of wood are fixed at the back of the ladders at top to keep them from the brickwork, thus providing a good foot and hand hold for the workmen.

The procedure of laddering is as follows:—The first length or section of ladder is placed at the base of chimney shaft, and a hooked wrought iron dog or holdfast, made from ⅞in. round rod, about 9in. long, is driven firmly into the brickwork 4ft. from the bottom of the ladder, and a second iron dog driven into shaft about 4ft. down from top of the ladder, to which dogs the ladder is firmly lashed. The dogs are formed so as to prevent the lashing of the ladders from slipping when any strain comes upon them—see the annexed engraving. Having lashed the first length, the next step is to place a free ladder against it. This the workman climbs until he can reach about 4ft. above the fixed length. Here he drives into the brickwork an iron dog, and attaches a pulley block to the same; then one end of the rope reeved round the sheave is brought half-way down a second loose section of ladder placed by the side of the first, the rope being fastened; the second length is hauled up by workmen at the base of the shaft until it is half its height above section No. 1; it is then temporarily lashed to the fixed length, and Steeple Jack climbs up and drives another holdfast into the brickwork 4ft. above its (the second length's) top. He then shifts the pulley block to the upper holdfast and descends. Length No. 2, still attached to the rope at its middle, is then hoisted above the first length fixed, which it overlaps two rounds, and the top of No. 1 and bottom of No. 2 are then securely lashed together, and No. 2 then forms a continuation of the first fixed length. The climber mounts No. 2 length, which is still held by the pulley block and rope, and drives in a holdfast above, shifts the pulley block, and proceeds with No. 3 as he did with section No. 2, and so on until the underside of cap is reached, and here a difficulty presents itself. In Messrs. Dixon's shaft, at about 10ft. down from the top, a stone cornice projects 3ft. The length of ladder coming close underneath this cornice or cap was fixed very firmly. Another length was hauled up until its top was about 5ft. above the cornice, and then this slanting length was secured to the length below at its foot at intermediate points, and also close underneath the cornice, by lashings or ropes specially made. In climbing this slanting length the workman's back is towards the ground. A last length of ladder is hauled up and fixed above the cornice, reaching to the top of shaft, and to the bottom of this the top of the slanting ladder is firmly fixed as an additional security, thus completing the laddering of this tall chimney shaft. The whole operation of thus climbing the 300ft. was accomplished in five hours.



The shaft is now being pointed with mastic about 50ft. down, and two cracks which are on opposite sides of the chimney, and extend to the bottom, are being repaired.

TRAMWAY-TRAINS.

At a meeting of the Société des Ingénieurs Civils, which took place on the 4th of March, the subject of "Tramway-Trains" was brought forward by M. Cossmann. This appellation has been chosen to designate light conveyances which, like tram-cars, stop frequently, but have a velocity equal to that of the ordinary trains. It is nearly ten years since they were first tried in Austria, and in the environs of Berlin; from thence the idea spread into France, and was adopted with certain modifications in accordance with the different requirements and the restrictions of the Legislature. To authorise a departure from existing regulations a presidential decree was found necessary, which was granted on the application of the Administrators of the State Railways. The three articles of this decree related to the length of the trains, the number of men accompanying each train, and the precautionary measures to be observed *en route* and at the stations; the rate of speed also to be determined by ministerial orders.

The question appears to have fallen into abeyance for about two years. At the end of that time, in 1884, the Compagnie du Nord, alarmed at the falling off of their traffic, took measures to reduce the working expenses of each line in proportion to the receipts, and resolved to try the system of tramway-trains on a branch of their Belgian line, and on two of their French lines. The system had already been applied in a suburb of Liège, on a line running between that town and Maëstricht. Of the two French lines, that between Lille and Tourcoing was considered suitable for the trial of a single carriage tramway-train, and on the line running from Boulogne to St. Omer, it was thought that light trains composed of several carriages would be better fitted to the requirements of the traffic. The happy results of this triple experiment, which was inaugurated on the 15th of July, 1885, decided the company to develope and extend the application to several sections. The present length of way is 475 kilos., and the projected extensions would increase it to 800 kilos. At the end of this year tramway-trains will be seen circulating between the Station du Nord, St. Denis, and the St. Ouen Docks, over a single and especial line distinct from the principal lines. The other companies are beginning to follow the example of the Compagnie du Nord. To the East there are two lines in the Department of Meurthe-et-Moselle; to the West it is proposed to extend the system to the Bretagne lines, and to some branches of the Seine valley. Since the 21st of September tramway-trains have been running from Villeneuve, St. Georges, to Palaiseau, and an extension is contemplated between Plaine and Pantin. The characteristics of the tramway-trains employed over the Northern section are as follows:—(1) They are composed of an engine and one large carriage, or of a limited number of carriages—at most six—and have no brake van. For such light trains an engine of moderate power is sufficient to keep up a relatively high rate of speed, and this is maintained in spite of the numerous stoppages, the number of which is regulated by the public requirements. A driver and one guard only are required, where the trains have but one carriage; where they have more than one but less than seven, two men on the engine and one conductor are requisite; (2) the stoppages take place at points between the stations, where there are neither signal boxes nor ticket offices, the tickets being distributed in the train itself by the guard as in the ordinary tramways. In establishing tramway-trains in connection with their railways the Compagnie du Nord has had to make two distinct provisions for their service:—(1) In the neighbourhood of the great centres, such as Paris, Lille, Maubeuge, the tramway-trains composed of one carriage are worked in correspondence with the existing trains by the addition of another line, and are confined to passenger traffic only; (2) on the branch lines, where the goods and passenger traffic are distinct, the ordinary trains are substituted by light trains, composed of from one to six carriages at most, without a brake van; they carry the mails, parcels, and passenger luggage, and like the one-carriage trains, stop at intermediate points. Being light and provided with the continuous brake, they are able to stop and start very rapidly. These trains, where the service requires it, can be converted into ordinary trains by the addition of carriages, a brake van, and the ordinary number of attendants. The company has avoided the construction of new material, and have in most cases adapted the old to the requirements of the new service.

The engines employed are the old Stephenson locomotives, the tenders of which are suppressed, and provision made, at the side, for the accommodation of fuel and water, in order to leave the passage between the engine and the platform of the carriage perfectly free. These engines are about fifteen tons in weight, and have a tractive power of three tons. The carriages are composed of two old carriages united, having a passage down the centre, and platforms at the extremities. They are eleven metres long, and contain seventy-five places in three classes, with a compartment for the guard. The carriages used in the vicinity of Paris are composed of three thrown into one, and have 102 seats. The light trains have the common form of carriages, that they may be converted into ordinary trains as the case demands.

The arrangements made at the stations are as rudimentary as possible; two platforms of earth are formed, contiguous to a crossing, and put under the superintendence of an attendant. The number of stoppages is now forty-seven, and they are being increased every day, in answer to the demands of residents, who are willing themselves to bear the slight expense incurred in installing them. The rate of speed is about the same as that of the ordinary trains; although there are double or treble the number of stoppages, they are of short duration, so that but little time is lost.

Taking the results obtained on the Lille and Tourcoing line, the working expenses of the tramway trains of one carriage amount to 0f. 4031 per kilometre, and those of the light trains of six carriages to a maximum of 0f. 60c., while a mixed train costs at least 70c. It will be seen then that a real advantage is gained in substituting the ordinary trains by tramway or light trains. It is more difficult to justify the economy of inserting tramway-trains into the existing service, since there is in the first place a supplement of expenses to take into account, but the system is to be recommended where the traffic is likely to increase and require more trains. It should not be concluded that this system can be profitably applied everywhere; the question should be studied line by line to determine where it could be adopted with advantage or otherwise. The object in view in starting tramway-trains in Austria was to promote local traffic. To provide for at least three or four journeys per day, where the travellers would not exceed in number some eight or twelve persons per journey, it did not pay to run the ordinary heavy trains; the wear and tear of the rails and other expenses quickly swallowed up the receipts. It was decided, therefore, to set light engines and carriages upon the rails, to work at a reduced speed and to stop at close stages. In consequence of this reduction of speed they have been able in Austria to reduce the tariff 33⅓ per cent. below the ordinary prices. According to M. Kopp, the receipts in the suburbs of Vienna in 1880 amounted 1f. 14c. per kilometre, and the expenses to 54c. only. The speed is generally fixed at 30 kilos. per hour, and descends in some cases as low as 23 kilos. The project has been worked out very successfully, and the example has been followed by Germany, France, Italy, and Belgium. In the latter country, however, the general use of tramway trains is still under consideration; as yet they are only employed around Liège and on the Chirnay line.

COMPOUND PASSENGER ENGINE.

We publish as a supplement this week drawings of the fine compound passenger engine, built by Mr. T. W. Worsdell for the North-Eastern Railway, and shown at the Newcastle Exhibition. In The Engineer for January 14th will be found engravings of a compound goods engine, the first compound goods engine used on an English railway, and in our impression for February 4th will be found an external elevation of the passenger engine. It will be noticed that the crank webs are circular discs. The chimney is extremely small. Engines of this type are now working the fast passenger traffic of the line with the greatest success.

We append a tabular statement of the principal dimensions:—

Principal Dimensions of Compound Passenger Engine.

Cylinder, high-pressure:—	ft.	in.	
Diameter of cylinder	1	6	
Stroke of piston	2	0	
Length of ports	0	11¾	
Width of steam ports	0	1¾	
Width of exhaust ports	0	3½	
Distance, centre line of cylinder to valve face	1	1	
Lap of slide valve	0	1⅛	
Maximum travel of valve	0	5¼	
Lead of slide valve	0	0 1/16	
Distance apart of cylinders, centre to centre	2	0	
Distance apart of slide spindles, centre to centre	2	0	
Cylinder, low-pressure:—			
Diameter of cylinder	2	2	
Stroke of piston	2	0	
Length of ports	1	5	
Width of steam ports	0	2	
Width of exhaust port	0	3½	
Centre line of cylinder to valve face	1	5	
Lap of slide valve	0	0 15/16	
Maximum travel of valve	0	5¼	
Lead of slide valve	0	0⅜	
Inside clearance of valve	0	0⅛	
Motion, Joy's system:—			
Diameter of piston-rods	0	3	
Length of slide block	1	3	
Length of connecting rod between centres	6	1	
Wheels, cast steel:—			
Diameter on tread, driving and trailing	6	8¼	
Diameter on tread, leading	4	7¼	
Throw of crank pins for coupling rods	0	11	
Diameter of crank pins for coupling rods	0	3¾	
Length of crank pins for coupling rods	0	4 1/16	
Thickness of tires on tread	0	3	
Width of tires on tread	0	5½	
Crank axle, steel:—			
Diameter at wheel seat	0	9	
Diameter at bearings	0	8	
Diameter at centre	0	7¾	
Distance between centres of bearings	3	10	
Length of wheel seat	0	7 7/16	
Length of bearing	0	9	
Diameter of crank bearings	0	8¼	
Length of crank bearings	0	4½	
Distance between centres of cranks	2	0	
Leading axle, steel:—			
Diameter at wheel seat	0	8½	
Diameter at bearings	0	7	
Diameter at centre	0	6¾	
Length of wheel seat	0	7⅜	
Length of bearings	0	11	
Distance between centres of bearings	3	8	
Trailing axle, steel:—			
Diameter at wheel seat	0	9	
Diameter at bearings	0	8	
Diameter at centre	0	7¾	
Length of wheel seat	0	7 7/16	
Length of bearings	0	9	
Distance between centres of bearings	3	10	
Frames, steel:—			
From centre of leading wheels to front buffer beam	5	4	
From centre of leading to centre of driving wheels	7	9	
From centre of driving to centre of trailing wheels	8	8	
From centre of trailing wheels to back end of frame	4	2	
Distance apart of frames	4	0	
Thickness of frame	0	1	
Boiler, steel:—			
Height of centre line from rail	7	8	
Length of barrel	10	7	
Diameter of barrel outside	4	6	
Thickness of plates, boiler barrel	0	0½	
Thickness of smoke-box tube plate	0	0¾	
Pitch of rivets	0	1⅞	
Diameter of rivets	0	0⅞	
Fire-box shell, steel:—			
Length outside	6	0	
Breadth outside, at bottom	3	11	
Depth below centre line of boiler at front	5	6	
Depth below centre line of boiler at back	4	7½	
Thickness of throat plate	0	0⅝	
Thickness of sides and top plate	0	0 9/16	
Thickness of back plate	0	0 9/16	
Pitch of copper stays	0	4	
Diameter of copper stays	0	1	
Roof stays, cast steel, girder section			
Inside fire-box, copper:—			
Length at bottom inside	5	3 9/16	
Breadth at bottom inside	3	2⅞	
Top of box to inside of shell	1	3½	
Depth of box inside at front	6	5	
Tubes, brass:—			
Number of tubes	242		
Length between tube plates	10	11⅛	
Diameter of tube outside	0	1¾	
Thickness of tube No. 11 and No. 13 B.W.G.			
Heating surface of tubes	1211·3 sq. ft.		
Heating surface of fire-box	112·0 ,, ,,		
Total	1323·3 ,, ,,		
Area of fire-grate	17·33 sq. ft.		
Working pressure per square inch	170 lb.		
Weight of engine in working order:—	Tons.	cwts.	qrs.
Leading wheels	12	18	0
Driving wheels	17	19	0
Trailing wheels	12	9	3
Total weight	43	6	3

The tender is of the same dimensions as those of the goods tender.

UTILISATION OF OLD SETTS, BROKEN FLAGS, AND STONE REFUSE, &c.

A new departure in stone-breaking, granulating, and screening machinery has recently been introduced by the Corporation of Burnley for converting the above-mentioned waste materials into broken stones of any specified size for concreting purposes; sand for mixing with the same; shingle or racking of a cubical form for inserting in the joints of paving to be afterwards grouted with asphalt or cement, and materials for tar-paving. The cost of production is at the rate of threepence per ton, and all the different kinds are perfectly clean, separate and distinct from each other, and ready for immediate use. These materials are required in enormous quantities in towns, especially where impervious paving is put down; and the average cost per ton in the majority of towns using at least 10,000 tons per annum is as follows:—Broken stone 2¼in., 3s. 9d. per ton; shingle or racking, 6s. 6d. per ton; fine sand, 4s. per ton—an excess of 75 per cent. as compared with the cost of the materials at Burnley.

Any new apparatus or novel arrangement having for its object an improved method of preparing and producing materials for engineering works—especially if capable of utilising waste substances such as have been mentioned, and at a nominal cost—will be interesting to municipal engineers in particular. Amongst some of the advantages of this apparatus we may mention that six different kinds of material, varying in size from fine dust to stone for concreting purposes, can be produced at one operation, and automatically discharged direct into carts or wagons at a saving of one-half the cost of the arrangement at present generally in use. The old-fashioned revolving circular screen in connection with the Blake type of stone-breaker does not sufficiently separate the different sizes, and this defect causes serious objections to be made by engineers and builders, especially in reference to broken stone for concreting purposes, and shingle or racking for paving works. On account of the broken stone not being perfectly clean and free from small particles of dust, a greater quantity of smaller material than specified is contained in the aggregate, which consequently adulterates the cement and greatly reduces the strength of the concrete; and, the shingle or racking not being perfectly clean and free from finer particles and dusty substances, the asphaltic mixture for grouting will not adhere to it, and the paving is not rendered impervious. One of the important features of this machine, we are informed, is in its having a combined radial, oscillatory, and positive shaking action, being precisely similar in motion to riddling by hand, the material is turned out as clean and distinctly separate as if it had been washed.

For separating and screening sand and gravel beds, ashes, and dust, the breaking machinery is dispensed with, and the screening part of the apparatus could, it is thought, be beneficially and economically made use of to obviate the very objectionable and highly dangerous practice of sieving the contents of dust bins by females and youths. In producing materials for concreting purposes, the machinery can be regulated to produce the specified proportion of sand required. River gravel and waste materials, such as old bricks, broken flags, and boulder can be reduced to angular fragments and used for spreading on wood and granite pavements in wet and very hot weather. More material can be dealt with than could formerly be done by the old breaking-machine and revolving circular screen arrangement which previously existed in the town; the products are more uniformly cubical in shape, and much less waste of material is experienced. We are informed that since the introduction of the system at Burnley, a saving of £200 per year in working expenses alone has been effected in the production of chippings or racking for paving purposes.

ARCHÆOLOGICAL THRESHING IMPLEMENT.

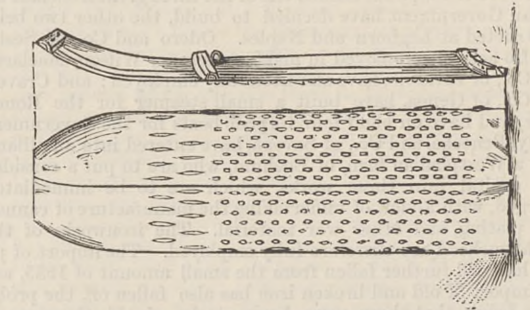
The meeting of the American Anthropological Society of Washington on November 16th was devoted to the reading of two papers bearing on the antiquity of man in America. Mr. G. K. Gilbert, chief geologist of the U.S. geological survey, described minutely the finding of an ancient hearth on the southern shore of Lake Ontario, at the bottom of a well about thirty feet deep.

Mr. Gilbert was followed by Mr. W. J. McGee, who described the finding of an obsidian spear-head or knife, four inches long and beautifully chipped, in Walker River Cañon, Nevada.

Mr. John Murdoch reported at the same meeting the discovery of a pair of wooden snow-goggles, like those now used by Eskimo to protect the eyes from the glare of the sun and driving snow, in a shaft which his party dug at the depth of twenty-seven feet below the surface. Mr. Murdoch's discovery made an interesting connecting link in the interpretation of Mr. Gilbert's hearth.

"Two of these finds," says Mr. O. T. Mason in *Science*, "were neolithic of the most advanced type, and located at the close of the last glacial epoch: they certainly start ten times more questions than they answer.

"The national museum has lately acquired two specimens from different parts of the world, which introduce an element of confusion into archeological speculations. Both of them represent the use of stone implements of the very rudest type by



ARCHÆOLOGICAL THRESHING IMPLEMENT.

peoples above savagery. One of these specimens is a *tribulum*, or threshing-sledge, from Tunis. It is a low sledge or drag made of two planks, seventy inches long, nineteen inches wide, and ten inches thick, turned up slightly at the front, and narrowed like a square-toed shoe. Three stout battens across the upper side are securely nailed down. On the under side, just where the flat portion commences, are seventeen strips of iron, like dull knife-blades, arranged in two rows quincuncially. Along each margin of the under side are four similar dull blades. All the remainder of the bottom is occupied with sixteen rows of stone teeth, sixteen in a row, arranged quincuncially and projecting about an inch. These teeth are nothing but bits of jagged quartz, and, if picked up independently of their environment, would hardly be regarded as wrought by human hands.

"The other 'paleolithic' civilised implement is a Spanish *Rallador*, or grater, from British Honduras. It consists of a plank of hard wood eighteen inches long and ten inches wide, into which have been driven nearly two thousand bits of quartz no larger than tiny arrow-heads, only they are not chipped in the least, and are less shapely.

"With such material as the Gilbert hearth, the McGee spear-head, the Murdoch spectacles, the Tunis *tribulum*, and the Honduras grater accumulating around us every day, the question does not seem to be as to the antiquity of man, but whether or not archæology will help us in ascertaining his pristine condition on this continent. Dismissing the *tribulum*—the stone furniture of one of them would stock an African paleolithic cabinet—we have evidence which would satisfy some minds that at the end of the glacial epoch there lived men who built fires, chipped obsidian most beautifully, and wore snow-goggles, while in the nineteenth century A.D. men were still in the lowest story of the stone period."

LETTERS TO THE EDITOR.

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

TORPEDO BOATS' BOILERS.

SIR,—Permit us to point out that although the boiler illustrated in your last issue represents the form we usually adopt, still it does not show the boiler as fitted in the torpedo boats lately built by us for the British Admiralty; these were not provided with the drop in the top of the box. YARROW AND CO.

Isle of Dogs, Poplar, E.,
30th May.

SIR,—With reference to your excellent article of last week, I should like to say that I agree with your remark as to the failures of two furnace crowns of direct draught torpedo boat boilers. But I fail to see why the particular system of fire-box staying should be adopted; it is certainly used on the Continent, in the United States, and at home to a certain extent, but it does not follow that it is the best for sea-going boats. I have had charge of trial trips at sea, and have been connected with boiler design and construction during the best part of twenty-three years, but I should feel rather nervous with flat fire-box crown plates, and any kind of stays whatever. In a letter to another journal—October, 1883—I gave one reason why the crown plates should be curved in addition to the ordinary girder stays, and with or without slings to the shell or fire-box casing. Another reason is that the curved top allows an average water working level at moderate "lists" of the boat. I notice the fire-box crowns of Messrs. Yarrow have a set down, which I consider an important feature—it gives the much required elasticity and strength. What applies to a ship's mast applies to a furnace crown—viz., that rigidity is not strength.

With crown stays screwed in plate, there should be a lock nut on underside—not simply passed through the plate with a head or nut underside, or cold rivetted. P. H. SADLER.

170, Cape Hill, Birmingham, May 31st.

OCEAN PENNY POSTAGE.

SIR,—I note with lively satisfaction that although the leading article which appeared in THE ENGINEER of May 6th criticises with severity certain views attributed to me, it yet manifests a friendly and encouraging interest in the question of cheapening and stimulating our communications with the colonies, and with the outer world generally. I am gratified to observe that the inspiring principle of our movement meets with your approval, and excites your sympathy, and beg to thank you for your opening remarks to this effect. The mighty aid of the Press as a whole has indeed been freely and generously extended to me. The acute journalistic mind has doubtless on numerous occasions subjected my case to impartial and searching examination. But the objections, or perhaps I should say, doubts, raised in your article are I believe now heard of for the first time in this controversy. It is well that they have been raised; but by your leave and courtesy I shall proceed to remove them.

1. Your first point is, in effect, that I have from first to last assumed a ton of letters to be worth no more than a ton of goods, and have then proceeded to complain that the public has to pay more for the carriage of letters than for that of goods. You justly argue that a ton of the national correspondence is far more valuable than a ton of ordinary merchandise, and that an extra charge, in the nature of insurance, must be paid for the safe-keeping and rapid transmission of the former. In answer to this I have merely to say, Sir, that in no letter or speech of mine on this subject have I fallen into the ludicrous error charged against me; and I can only suppose that my utterances have been imperfectly brought before you. That a man should seriously hold, say, a ton of rags to be worth as much as the paper made from them, when this paper has taken the form of cheques, banknotes, orders for goods, &c., would be a damning fact in the event of a writ *de lunatico inquirendo*, having reference to his mental condition, being issued. I have consistently set forth my contention on this head as follows:—The ordinary rate for the conveyance of valuable goods by sea is £2 per ton. We say, let the charge to the public for letters be £300 per ton, or 150 times as much as for valuable goods. This sum of £300 would be realised by the charge of 1d. per letter. Surely the difference between £2 and £300 is sufficient to allow of payments on any conceivable scale of magnitude for safe-keeping, insurance, and cost of collection and delivery. The present Post-office charge is as high as £1792 per ton. I would further observe on the subject of safe-keeping that letters are invariably sent by swift passenger steamers; and that we may rely upon the minutest precautions being taken by the steamship companies to insure the safety of their passengers, whose lives are even more precious than mail bags. It follows that no expenditure beyond that involved in keeping the bags in a water-tight receptacle is imposed on the carrying agents.

2. Your second doubt may be thus expressed:—The lowering of the rate to one penny would largely increase the bulk of the correspondence—which statement I am delighted to endorse—and the increased space thus necessitated "cannot be given by the mail lines without adequate remuneration, in addition to the present rates of subsidy." Allow me, Sir, to assure you that this is a pardonable mistake—which I should perhaps have shared, but for a fact which is within my knowledge. This fact is that the companies in question are willing to carry at least six times the present volume of the letters without additional charge. This fact I have laid before the Postmaster-General; and let me add that we do not ask for a diminution of the rates on newspapers, &c., but only of those on closed letters. As the second class occupies, in comparison with the first, only a fractional amount of space, the increase of bulk would not be nearly so considerable as might at first be supposed.

3. You have a third and important reason for hesitation. You refer to the great cost of a first-class mail steamer, and to the "expenditure necessary to add a speed of only a single knot per hour;" and you urge that the State defrays this cost by its subsidies, and is entitled to be repaid this expenditure by means of a heavy postage rate.

I reply that these subsidies are totally unnecessary. In the first place, I have personally received, and transmitted to the Postmaster-General, the offer of a first-class steamship company to convey the mails to Australasia—the longest possible voyage—for one penny per letter. These huge subsidies are admittedly paid in order—(1) to maintain our commercial transport service in a high state of efficiency, and (2) to keep always ready for the event of war a fleet of the finest steamers afloat—both objects of high State policy, but utterly unconnected with the postal service.

It is further to be observed that vessels are now being built fitted with "triple expansion" engines, which ensure great speed, while consuming much less coal than has hitherto been required. The Ormuz, *e.g.*, only cost £210,000, and she has carried the mails between Australia and England in twenty-six days twenty hours, instead of taking the full contract time—thirty-seven days. Suppose we were to capitalise the £170,000 paid annually for the Australian service. We could then build sixteen vessels of the Ormuz type—enough to provide a weekly service to Australia, to defray all expenses, "insurance," &c., and to establish a sinking fund into the bargain; or we could achieve a similar result with half the sum—£350,000—paid for the Indian mails.

There are in Canada, the United States, and Australasia many millions of British emigrants, drawn almost without exception from families in humble circumstances, but none the less cherishing the memory of home ties, as men will always cherish anything which they have loved and lost. Sir, at the risk of being considered sentimental or extravagant, I declare that the reckless, wasteful system which wrings sixpences from the sweat and tears of these humble toilers is not merely an economical scandal, but a national sin. Last year from 100,000 middle-class people in Australia their relatives in this country received in small postal orders of from £1 to £8 no less a sum than £346,615, or nearly £1000 per day.

In conclusion, let me add that I simply ask for an inquiry into this important question, which equally concerns the development of our vast colonial trade and the dearest happiness of large classes of her Majesty's subjects. I have proved the existence of countless and monstrous anomalies; I have shown that these cruel rates can be minimised with positive advantage to the revenue. Even those who twelve months ago strenuously objected to an inquiry now support me in calling for it, with the notable exception of the Post-office department, which obstinately resists it. I appeal to you, Sir, whether the demand is or is not a moderate and reasonable one. J. HENNIKER HEATON.

Hôtel Continental, Rue Castiglione, Paris, May 28th.

[Mr. Heaton's appeal to us is sufficiently answered by our publication of his letter. We do not pretend to discuss the sentimental side of the question. When Mr. Heaton can demonstrate the soundness of his propositions on a financial basis, we shall alter our views, not before. There is really nothing in his comparison between a rate of £2 per ton for goods, and £300 per ton for letters. Can he state that any solvent competent company is prepared to carry letters to Australia at 1d. rates, accepting at the same time all the Post-office stipulations as to speed and time? If he can, half his case is won.—ED. E.]

THE DEVELOPMENT OF THE LEINSTER COALFIELD BY RAILWAY COMMUNICATION.

SIR,—In reading your issue of the 13th, I observed an article on the "Development of the Leinster Coalfield by Means of Railway Communication," and as I am at present assisting in projecting a light railway from Athy into the Leinster coalfields, having a long experience of the Kilkenny anthracite coal, I may perhaps enlighten some of your numerous subscribers on the uses of that coal, for steam generating purposes, &c., first making a few remarks as regards our projected line. No doubt the "Tramways and Public Companies Act of 1883" afforded facilities in the projecting and carrying out of many schemes of benefit to Ireland, still the chief reason why that Act is not used to a greater advantage is on account of the seriously defective financial arrangements afforded by it, which do not utilise in the most economical way the security afforded by the combined county and treasury guarantee for the capital required for the construction of railways and tramways in Ireland—the Government first requiring us to give them a full 5 per cent. before they grant the 2 per cent. provided for in the Act. It is hard to expect in these very depressed times that any railway undertaking in Ireland could be fairly projected without some amendment of such an existing law. There are many places in Ireland much in need of railway communication with the existing lines; and I may certainly put first in the list the Leinster coalfields. Mr. White, in his well-compiled paper, brought before the notice of the public many points of great interest regarding the nature of the Kilkenny and Queen's County coalfields; but his statistics on the price of coal are somewhat wrong, as the highest price at present, and for many years, is but 15s. per ton at pit's mouth, 13s. 4d. being considered the usual price for first-class coal.

Professor Hull, LL.D., F.R.S., Director of the Geological Survey, Ireland, in evidence before the Select Committee of Industries, Ireland, in 1885, said, "I hold in Leinster or in the Castlecomer district there is room for a very large expansion of the existing coal produce, which can be only brought about where a railway or some proper facilities are given for the carrying of it to the various parts of the country." His estimation is that there are 61,440 English acres in the Leinster coalfields, and 118,000,000 tons of workable coal; at ten times the present output per year, 169 years should elapse before the coal would "run out." There are but two workable seams of commercial value, namely, the Jarrow, upper, 2ft. 6in. to 3ft. in thickness, and Skahana, lower, a softer coal, 1ft. 6in. to 2ft. The workings are not much inconvenienced with faults, in reality there being only one fault of any serious character. The usual depth of shafts at present worked is from 80 to 95 yards.

The anthracite coal has always been, and is used for steam generating purposes with very good results, not only at the different shafts in the Leinster coalfields, but in the surrounding towns. There are at present upwards of twenty boilers working near Castlecomer, including "egg ends," Robey's stationary locomotive type, Lancashire, Cornish, and many other classes, with pressures varying from 40 lb. to 60 lb. per inch. I have seen two boilers which have been working at 40 lb. per inch constantly for the last thirty years, fired with anthracite of the cheapest description, without any deterioration to the plates or flues. The bars being made of wrought iron stand the great heat five times longer than those of cast. I have examined many bars of different design, and find in using anthracite coal the thinner the bar the better, having a section like an inverted isosceles triangle. The base offering a flat surface prevents clinking to a great extent, as in the ordinary cast iron section there exists a trough between the bars in which the anthracite invariably clinks. In the United States of America anthracite is used in locomotives, having a special bar, namely the "water-tube fire bar;" this bar also serves for heating the water before entering the boiler; in our temperate clime no such bar is necessary either in locomotives or land boilers. In all cases I find that by lowering the bars in the existing boilers a little anthracite may be successfully used. There is an acquired system for firing which is the most important item in obtaining good results from this class of coal. (1) To use coal of a small size—some engineers in the Jarrow are using slack at 3s. 4d. per ton and less with the highest results. (2) Not to fire too heavily at a time, as when the thickness of bed exceeds a certain point the lower portion becomes cool, which affects the rest, consequently the heat is reduced. (3) When the fire is well up not to poke too freely, as anthracite gives so little ash; once it is brought to a full heat poking is not advisable. Water in the ashpan also prevents clinking to a great degree and induces a draught. Any stoker who has had experience of this coal can manage his fire with so little labour or attention.

From the following careful analysis of the anthracite recently made by the late Professor E. T. Hardman, F.G.S.I., &c., it is clear that large results can be obtained from it. The new Jarrow coal from Massford is an extremely fine quality of anthracite, hard, dense, and homogeneous, containing very little sulphur and a small amount of ash. For malting purposes and corn mills it is especially adapted, owing to its lasting power and small traces of sulphur:—

	Analysis of new Jarrow coal. Per cent.	Analysis of Welsh anthracite. Per cent.
Fixed carbon	88·91	87·13
Volatile hydrocarbons with nitrogen, hydrogen, and oxygen	5·32	7·44
Sulphur	1·16	1·56
Water (hygroscopic)	2·11	2·27
Ash	2·50	1·60
	100·00	100·00
Coke, per cent.	91·41	88·73
Specific gravity	1·528	1·369

One ton of new Jarrow evaporated 2934½ gallons of water at 212 deg. Fah., while the same quantity of Welsh coal will only evaporate 2512 gallons; difference in favour of Jarrow, 422½ gallons per ton; so that 16¾ cwt. of Jarrow coal are equal to one ton of Welsh. Compared in an ordinary fire, the Jarrow coal lasts more than twice as long as the Welsh. This was confirmed in the laboratory with accurately weighted quantities, the Jarrow requiring two and a-half times the period of the other for complete combustion.

It may be interesting for you to know that a new industry has been started near Castlecomer in connection with the Jarrow coal, viz., the "Culm or Slack Brick" Factory. These bricks, 8in. by 4in. by 3in., are made of a composition of slack, clay, and fibre or sawdust, thus:—

	Per cent.	
Leinster slack	0 80	
Clay, with 1·19 per cent. of iron	0 15	Sp. gr., 1·211 (approx.)
Sawdust, peat, or fibre	0·05	
	·100	

These bricks, when dry, can bear handling well, and make an admirable fire, estimated price being a farthing each, two bricks being sufficient for an ordinary fire for eight hours. For locomotive, or, indeed, any boiler these bricks would be invaluable, both on account of their heating properties and being so easily conveyed throughout the country; the weight of 1000 equals 1 ton 6 cwt. I am at present designing a machine which will be capable of mixing, moulding, and drying over ten tons per day. There are at present some thousands of tons of slack at the different pits, and the daily increase is something considerable.

I shall be glad to forward you the results of some experiments I am at present engaged in with the anthracite coal, which I have no doubt will be of much interest to all steam users.

LUCIUS J. BOYD.

Boyd Ville, Crettyard, Queen's County, May 28th.

DOMESTIC DRAINAGE.

SIR,—As your correspondent of the 17th has made some statements, which will, no doubt, be taken for what they are worth by those concerned, I beg to thank him for his valuable opinion, and pointing out what he thinks had not occurred to me; but without encroaching upon your space, I beg to mention in one—the first—case only that he seems to forget that the drain is merely a waste carrier or duct, and is not intended to be full, but empty, except in the event of its being at any time stopped, by fat and sand, or other substance or obstruction, which would, as I said in my short note of April 19th, cause the water to rise to the first outlet, and there show itself, and consequently relieve the drain of any further pressure; and the stoppage can then be got at from the first manhole behind the stoppage, from the clogged side—*i.e.*, on the side past the stoppage—and certainly not by charging the drain on the stopped side, and tending to jamb the stoppage more and more. F. BOTTING.

May 30th.

THE FLIGHT OF THE PELICAN.

SIR,—If Mr. Lancaster must go to the Gulf of Mexico and the southern coasts of Florida for solution of problems of heavy bird flight—let him look, next time he goes there, and see if the action of the wings flapping is not practically the same as that of a double figure of 8, *i.e.*, much the same as occurs in sculling a boat with one oar over the stern, the blade being effective to right and left by reason of turning the oar. So also is the up-and-down stroke of the bird's wing equally effective in raising its weight in both cases.

May 31st. VITAL SPARK.

THE FASTEST VESSEL AFLOAT.

SIR,—I have referred to the report from which I quoted, but there is no mention of the load on board. I have reason, however, to believe that the Thornycroft boat was partially loaded.

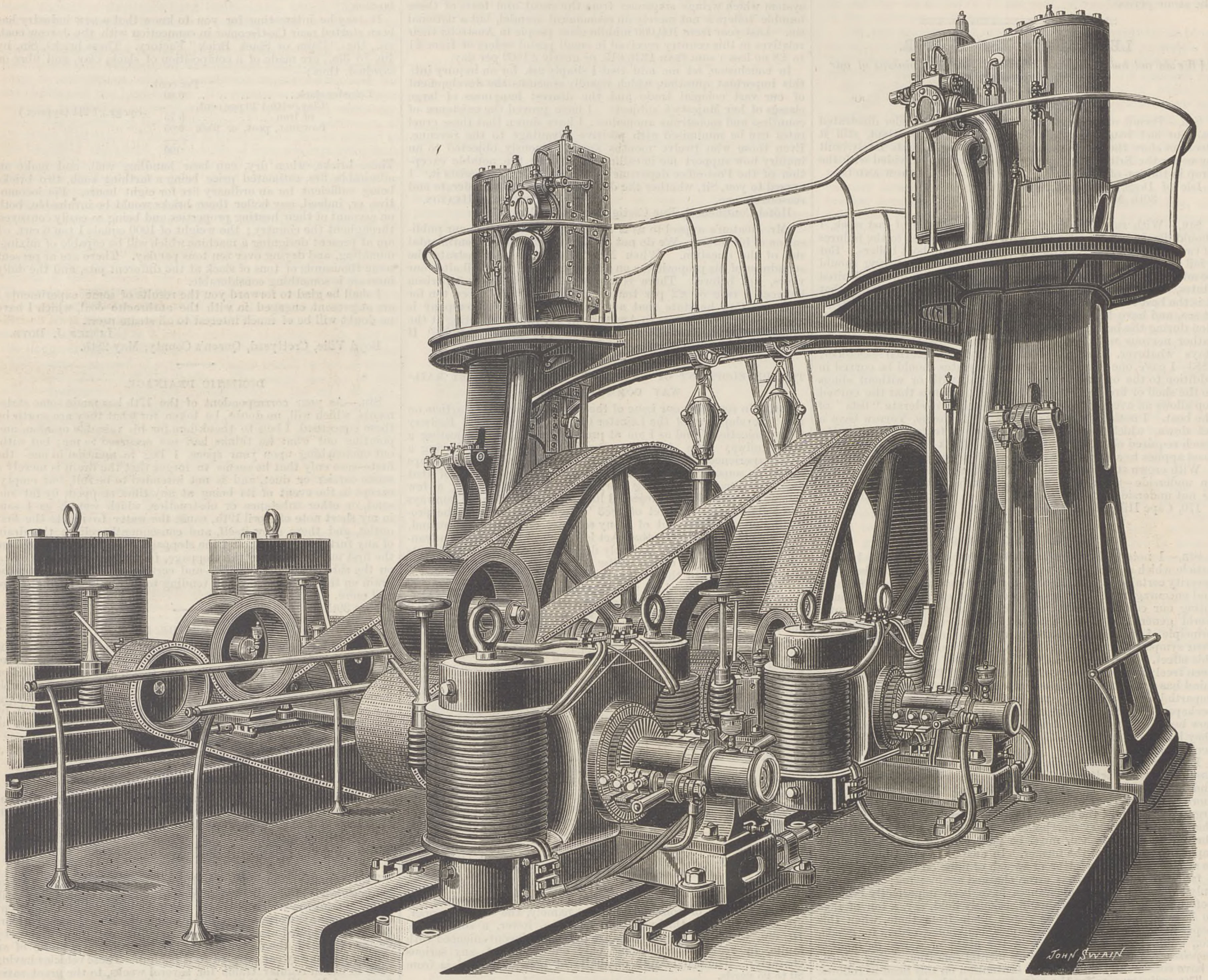
May 31st. FAIR PLAY.

THE HEBERLEIN BRAKE.—The Heberlein automatic friction brake has been lately applied with great success to a car on the Highgate Hill Cable Tramway, which is under the management of the Patent Cable Tramways Corporation. An open car which carries the grippers has been supplied at each end with a brake reel, with which, by means of a cord, the driver can control the automatic brake of an ordinary tramway car coupled to it behind. These vehicles having been in use in regular traffic for several weeks, to the great satisfaction of Mr. W. N. Colam, A.M. Inst. C.E., the engineer to the Corporation, special trials took place on May 19th, in the presence of Major-General Hutchinson, R.E., Government Inspector of Railways, who afterwards expressed his complete satisfaction with the simplicity, efficiency, and powerful automatic action of the brake. The most interesting experiment was intended to exemplify the effects caused by the rupture of the connection between the outside car and the ordinary type of car whilst ascending steep gradients. By good fortune, however, the proposed simulated rupture became an actual one, as the rope which, with a view to the experiment, had purposely been employed instead of the ordinary coupling and chain connections, broke unexpectedly just as the cars were ascending a portion of the hill where the grade is 1 in 10·8, thus affording the best possible proof of the efficiency of the brake, as it brought the detached car to a standstill on the incline before it had moved backwards more than about its own length.

MR. WILLIAM JACOMB.—The death was announced on Thursday, the 26th ult., of Mr. William Jacomb, the chief engineer of the London and South-Western Railway. On Tuesday Mr. Jacomb had, with Major-General Hutchinson, the Board of Trade Inspector, been over the lines now in course of construction under his superintendence between Clapham Junction and Barnes, the works on which are of a very difficult character. In the evening he returned to his office apparently in good health, and much pleased with the visit of Major-General Hutchinson, who had expressed himself well satisfied with the manner in which operations were being conducted. On Wednesday morning, the *Railway News* says, he was again at the office, and the afternoon was spent in making business calls at Westminster. Returning about half-past four, he sat down to go through the letters that had arrived in his absence, but was immediately struck down by a stroke of paralysis, from which he never rallied. Mr. Jacomb, who was only fifty-four years of age, was one of Brunel's favourite pupils, and under that great chief carried out many works on the Great Western system. He was also engaged on the building of the unfortunate Great Eastern steamer, and subsequently entered into partnership with his cousin, Mr. Robert Jacomb Hood, at that time engineer and now a director, of the Brighton Railway Company. During this partnership he was the engineer for the Tooting, Merton, and Wimbledon line, built jointly by the Brighton and South-Western companies, and during these operations he secured the confidence of the board of the latter company, who, on the resignation of Mr. Strapp, in August, 1870, appointed him chief engineer of the line. He was then only thirty-six years of age—a young man for so responsible a post. During the subsequent period—especially within the last few years—many most important works have been carried out, notably the enlargement of Waterloo station and the building of the new offices. He also planned and carried out the widening of the line from Waterloo to Clapham Junction, and was, as above stated, at the time of his death engaged on the line from Clapham Junction to Barnes. He was also the engineer for the line from Fulham to Wimbledon, the bridge for which across the Thames is now being carried out from his plans. In the country he designed the Bournemouth Direct, from Brockenhurst to Christchurch, the Netley and Fareham, and other useful additions to the system. He leaves a widow and one son—an assistant engineer in the company's offices—and a daughter.

THE MANCHESTER EXHIBITION—ELECTRIC LIGHT ENGINES.

MESSRS. MATHER AND PLATT, SALFORD, ENGINEERS.



THE MANCHESTER EXHIBITION.

THE Manchester Exhibition may now be said to be nearly, if not quite, complete; and it is working without hitch or impediment. Some trouble was experienced at first in the refreshment department, but additional sheds have been erected, and all trouble in this department will soon be overcome. The attendance has hitherto been very large. It is stated, indeed, that no fewer than 30,000 season tickets have been sold. The building leaves little to be desired; it has been tried by one heavy gale, and has borne the test successfully. The system of construction is so novel that it was natural some anxiety should be felt; but it will be seen, from the engravings published in our impression for May 6th, that the ironwork has all been put together on a sound principle, and there is no reason to doubt that it would endure much more violent storms than any to the fury of which it will be submitted. There were at first complaints that the glazing was not watertight; we have heard little of this of late, and take it for granted that exhibitors have been satisfied.

In previous impressions we have given detailed descriptions of the various electric light installations in the building, and we now give above an engraving showing in elevation the fine engines by Messrs. Mather and Platt, of which we have already published detailed drawings. We have described these engines so fully that we need add nothing to what we have already said.

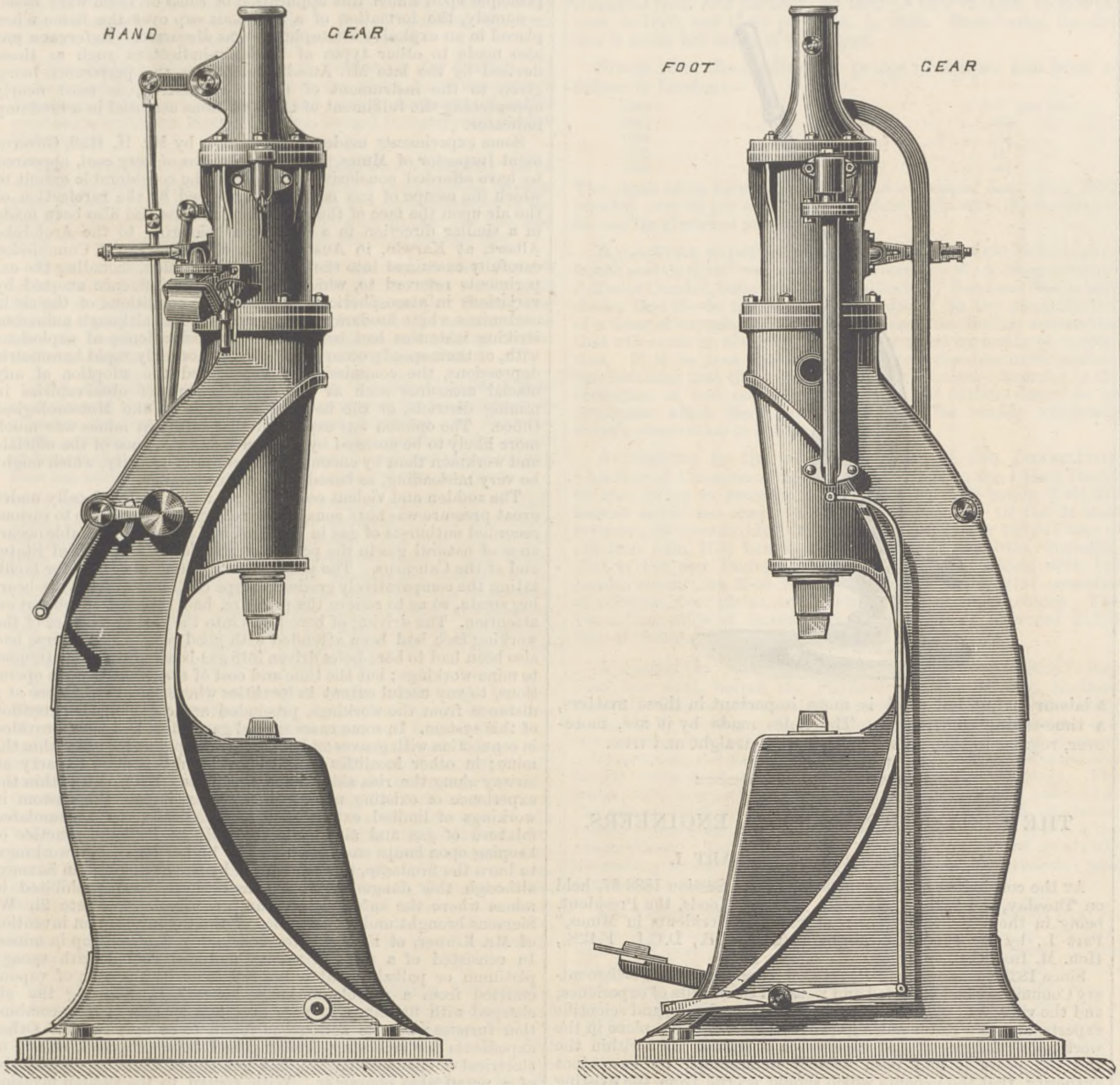
Most of the larger firms exhibit on so great a scale, that to do any justice to one all the space at our disposal for a week is required. This week we select for illustration the most striking of the machines shown by Messrs. Tangye, of Birmingham, which occupy a large space.

Probably one of the most interesting of these exhibits is the gas hammer, illustrated on page 439. In principle the gas hammer is exceedingly simple, and we have already described the hammer in our impression for Sept. 10th, 1886, as first made by Messrs. Tangye. During the last twelve months, it has undergone modifications and improvements in detail. In appearance it is hardly distinguishable from a well-designed steam hammer; but instead of steam furnishing the motive power, a mildly explosive mixture of common coal gas and atmospheric air is employed, and it is used to propel the hammer piston very much as in the cylinder of a gas engine. The mixture of gas and air is introduced to the cylinder above the hammer piston by means of a second piston actuated by a hand lever, and is then ignited; the pressure produced acts upon the upper surface of the hammer piston and so forces it down to give the blow. After the blow the hammer is returned to its highest position by means of a volute spring, so that the explosion is used only to give the blow and not to lift the hammer. The hand lever actuating the second or charging piston is arranged to move precisely like the hand lever commonly used in steam hammers for controlling the slide valve, the similar movement produces precisely similar results, and the effort required to move it is no greater; a boy can work the gas hammer just as easily as a steam hammer. The action of the hammer is as follows:—When the working lever is moved through its full ranges the charging piston connected to it moves to the top of the cylinder and away from the hammer piston, and gas and air mixture flows in through an automatic lift valve, filling the space between the pistons. At the limit of its charging stroke a small hole into the cylinder is uncovered and a Bunsen flame ignites the mixture through it. Under the pressure produced by the ignition, which in no case exceeds 70 lb. per square inch, the hammer piston is driven downwards and the hammer delivers its heaviest blow. In the case of the hammer exhibited at the Manchester Exhibition this blow is equal to that given by a weight of 3 cwt. falling through a height of 1ft. The return spring now lifts the hammer to its highest position ready for action again. The heaviest blows can easily be given at the rate of over 120 per minute. The force of the blow can be regulated as easily and as accurately as with the steam hammer. Softer blows are given by reducing the range of movement of the hand lever. Less movement of the hand lever means less movement of the charging piston, a smaller volume of charge, and therefore a lighter blow. For the very lightest blows a relief valve is provided which can be opened at will. In some cases it is an advantage to the smith to control the action of the hammer himself instead of having a boy to do so, and a modified arrangement is supplied when desired, to enable him to work by foot whilst having free use of both hands for handling the forging. With the foot gear precisely the same control over the force of the blow is attained as with the hand gear. Light and heavy blows are entirely at command. The size at present made is nominally of $\frac{3}{4}$ cwt. capacity, but the blow actually struck is equal to 3 cwt. falling through 1ft.; so that the hammer is more powerful than a steam hammer of similar rated power. For the past twelve months one of these hammers has been almost continuously employed in the regular operation of the smithy doing the very hardest kind of work, which it has done thoroughly well. It has proved beyond a doubt that the gas hammer is capable of severe and continuous work, just as much as the steam hammer. The economy is exceedingly good; 3000 of the heaviest blows only use 33 cubic feet of Birmingham gas, which, at 2s. 6d. per 1000 cubic feet, costs one penny, or 4500 light and heavy blows can be struck for the same sum. A week's hard work will only cost some 4s. for gas, and there the expense ends. There is no getting up steam or disposing of ashes; no packing of stuffing-boxes, or condensed water dripping from the hammer piston-rod on the forging. The hammer is always ready for work at any moment, day or night, for short or long periods, and it works at the same economical rate for one blow as for one thousand. It is only necessary to light the Bunsen flame, open the gas cock, and it is ready for action.

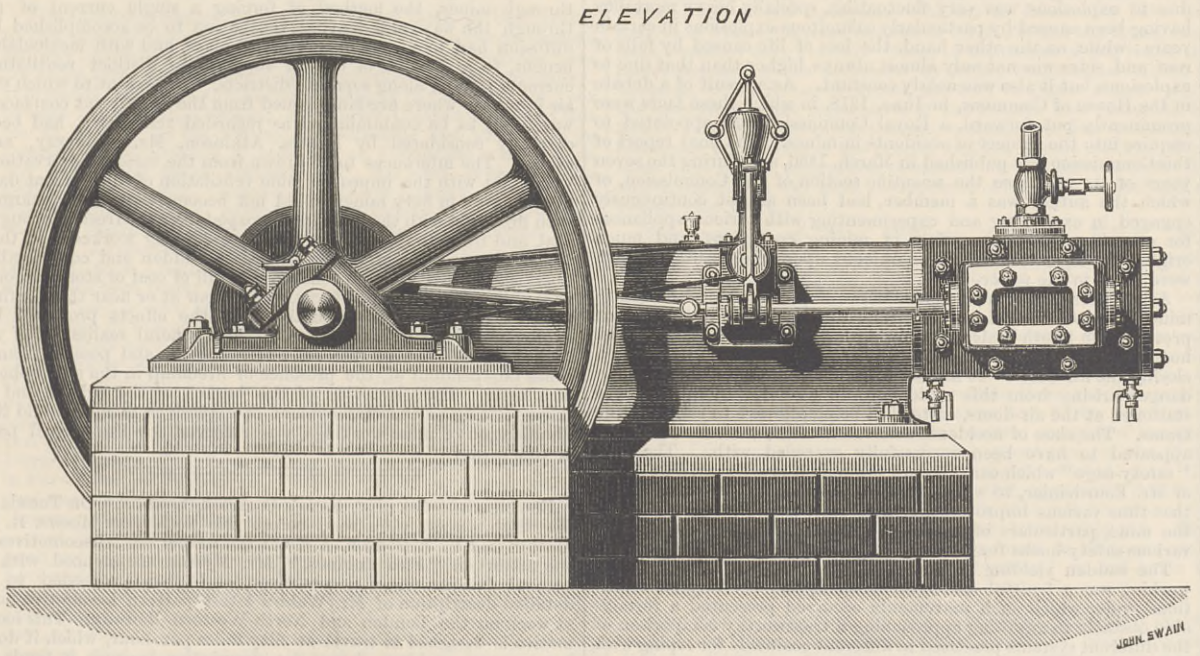
Messrs. Tangye show a nice little horizontal engine fitted with a novel cut-off gear, which we illustrate on page 439. The special features claimed are that it is exceedingly simple in construction and effective in its operation. Under a long series of trials its performance has, we are told, been very satisfactory. An examination of the sectional drawing will enable engineers to understand that the absence of complication has not been secured at the cost of trustworthiness. The cut-off valve A, which travels with the main slide valve, has an oscillating motion which is given to it by the cams B. The steam passes through the open end of the valve to the cylinder until the cam trips the cut-off valve and closes the open port, at the same time opening the closed port ready for the return stroke. The cut-off valve faces C are loosely fitted, so that on being brought into contact with the main valve, the external pressure adjusts them to the face, and before it is necessary to break this contact steam enters by the under side of main valve, puts them into equilibrium, and allows the valve to work freely. The engine is regulated by a Porter type governor, which is coupled to and partly rotates the spindle on which the cams are fixed. The cams shown are excentric, and as the load increases or decreases, so the positions of the cams are altered by the action of the governor to come in contact with the cut-off valve sooner or later, as required. The governor, which is of a new design, has the weight supported at a point above the centre of gravity by a column, having anti-friction washers on the top of it for a bearing, and also serving the purpose of a guide round which the weight rotates.

Messrs. Tangye's name is indissolubly connected with the hydraulic jack. On their stand at Manchester will be found a practically novel form of this useful machine, which we illustrate on page 440. The hydraulic pulling jack was originally designed for the purpose of pulling up large tree stumps when clearing woods, forests, and other estates of timber. It has since been found extremely serviceable on board steamships for raising cylinder covers, pistons, and other heavy weights. A large number has been supplied for this purpose of 25 tons power and under for our own and foreign navies. The construction will be readily understood from the sectional illustration. A is the cylinder, which can be made of any length to suit the required lift; B the piston in one piece with the tube C; D the cistern screwed to the tube C, and containing the pump E, which is actuated by the hand lever; G is a small tube, through which the liquid passes from the pump to the cylinder A; H is the release valve. When this is opened, the liquid returns from the cylinder A to the cistern D, and the load descends. The small passage I and the annular space round the tube G form a communication between the cistern D and the upper side of the piston B. Thus the space above the piston is utilised, and a very small cistern suffices for a run-out of any ordinary length.

Speaking of marine engines, it will not be out of place to notice here the direct-acting centrifugal pumping engine, intended for circulating through condensers on board steamships and other purposes, which pump we illustrate on page 442. The pump has an 8in. inlet and discharge branches, with a 3ft. disc keyed on a phosphor bronze spindle working in gun-metal bearings. This spindle is connected direct to the crank-shaft, which is of forged steel, with the throw slotted out. The steam cylinder is 8in. diameter, with a stroke of 8in., lagged with sheet steel, and fitted with relief valves and condensed water-cocks. It is bolted to a standard cast in one piece with the bed-plate, and is stayed in front with a bright wrought iron stay. The piston-rod, crosshead, and connecting rod valve spindle are all of forged steel, turned bright. The bearing surfaces are all oiled from a central lubricating box. It is an exceedingly compact and light pump, especially when the work it will do, viz., over 11,000 gallons per minute, is taken into consideration.

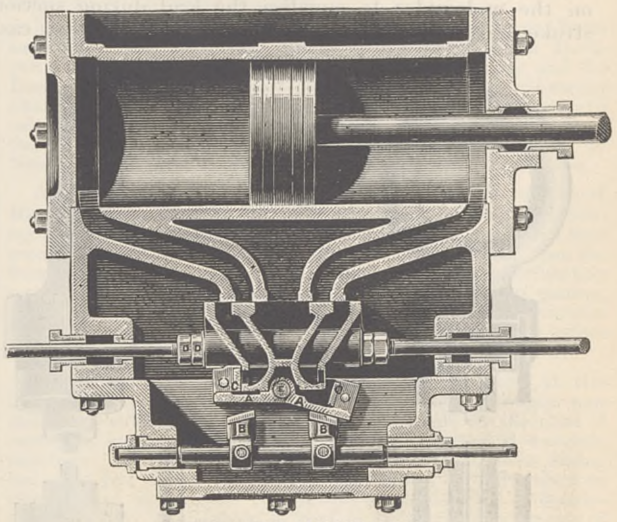


ROBSON'S GAS HAMMER.



HORIZONTAL ENGINE WITH AUTOMATIC CUT-OFF GEAR.

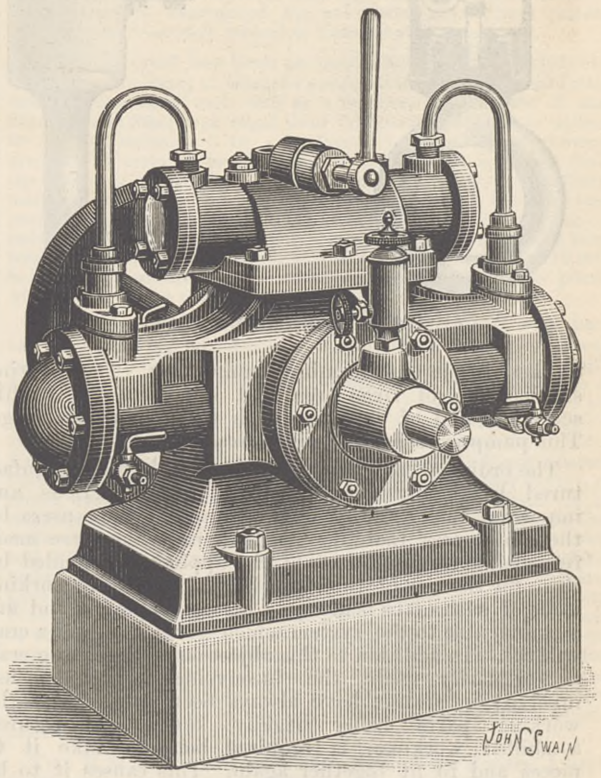
On Messrs. Tangye's stand will be found the curious high-speed engine which we illustrate above. This is a handy little engine, suited for a variety of purposes to which the high price and very complicated construction of many quick-speed engines have hitherto rendered their application impossible. This engine, it will be seen, has none of the few working parts exposed; they are, nevertheless, readily accessible, but with a view of avoiding the necessity for frequent examination and renewal, they are made of adequate strength and durability. The bearings are unusually long and substantial. There are no excentrics, no piston-rod, valve-rod, nor stuffing-boxes. The engine is right and left-hand, and will run either way. It is started, stopped, and reversed by a single lever. The lubrication is very complete and effective, and unlike other engines of the type, the exhaust steam in the case of this is not conveyed into the space in which the crank revolves, but into the atmosphere. The slide valve is of the ordinary type, and is operated by valves situated near the ends of the steam cylinders; these valves working on a system similar to that adopted in one shape or another by various makers of steam pumps. The crank revolves in the lower part of the frame, which forms an oil bath for the crank bearings. Cast in a piece with the frame are the two steam cylinders, which are fitted with trunk pistons. These are connected to the crank by strong wrought iron connecting-rods with wide brasses and two strong wrought iron rings, held by a steel bolt. The smaller ends of the connecting rods are secured to the pistons by steel bolts. The whole arrangement is substantial, and no adjustment of the connecting-rod bearings is



AUTOMATIC VALVE GEAR.

necessary. The crank shaft is fitted with a brass centrifugal oiling disc, which, together with the oil bath already referred to, ensures effective lubrication of all the working parts. The crank shaft projects on both sides of engine, hence the fly-wheel and driving pulley may be interchanged.

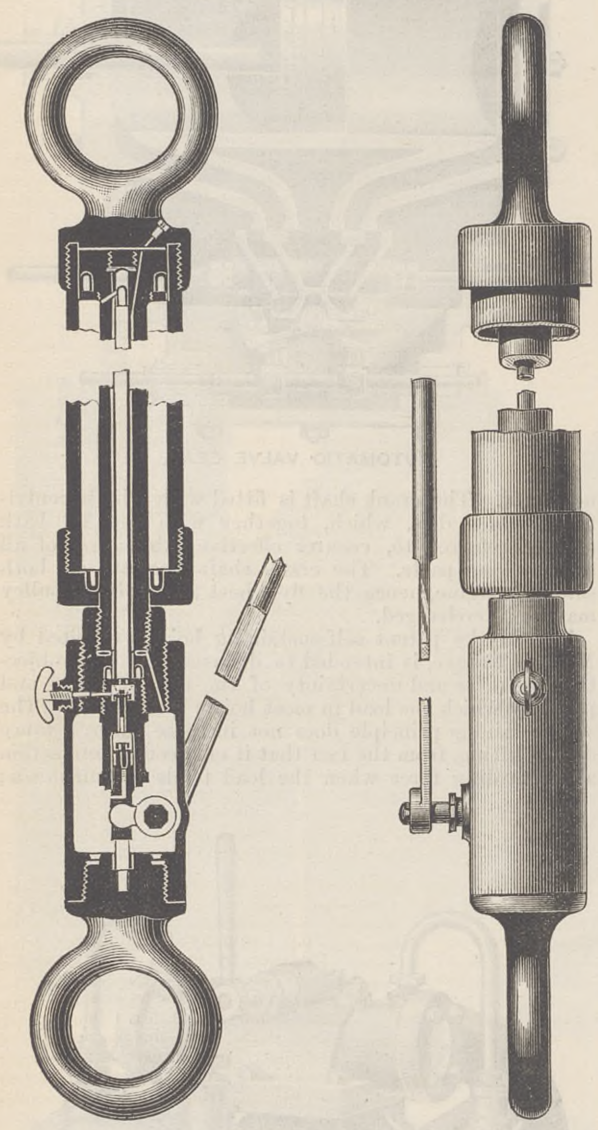
The Marks patent self-sustaining hoist, exhibited by Messrs. Tangye, is intended to dispense with the objectionable noise and uncertainty of the ratchet wheel and palls, by which the load in most hoists is sustained. The self-sustaining principle does not increase the resistance during lifting, from the fact that it only comes into action as a retarding force when the load tends to run down;



HIGH SPEED ENGINE.

and the adjusting feature introduced upon the brake is a check against overloading, the hoist being set to lift the load for which it is constructed, and to slip round with any greater load. We illustrate this on page 442. Upon one shaft A is keyed a brake wheel C, and upon another shaft B a disc D, which is slightly excentric, runs freely. At one position of this disc, when bearing against the brake wheel, it tends to come in as a wedge, if the brake wheel turns in the direction which will cause the disc to move towards it; but if turned in the contrary direction the disc will be moved away from the brake, and it will free itself. The action of lifting the load is that which causes the disc to move from the brake wheel, while the lowering brings it into wedge. A lever E on the disc admits of its being liberated when the load has pulled it on, pulling which hard will bring the excentric quite clear of the brake wheel, but will at the same time tighten the brake strap F and hold the load; and should the attendant slightly loosen this strap by decreasing his pull, he can lower the load at any speed at will; whereas, should he, when rapidly lowering, let go altogether, no damage of any kind will result, as the excentric will simply be drawn into its fixed stop G, and thereby gradually arrest the descent. Thus by one hand cord the man has complete control over the lowering. The same principle has been very successfully adopted on cranes and travellers made by Tangyes.

On page 442 we illustrate a high-lift Colonial pump, of the vertical double ram type, having inverted cylinders 16in. diameter, rams 8in. diameter, and 16in. stroke, capable of delivering 22,000 gallons of water per hour, which on an emergency can be exceeded. The pump barrels, valve boxes, and air vessels are cast together to form a standard, which is spread out at the top to carry the cylinders and at the bottom to form crank shaft bearings. The pump barrels are placed over the crank shaft, which is connected to the rams by forked connecting rods, sweeping the undersides of the barrels. Pump mitre valves of large area are placed behind the barrels at the side of the standard, and communicate by large water passages with the air vessels, which are provided for both suction and delivery. The piston areas are reduced on the undersides to equalise the load during suction stroke and economise steam by means of trunks, cast



HYDRAULIC PULLEY JACK.

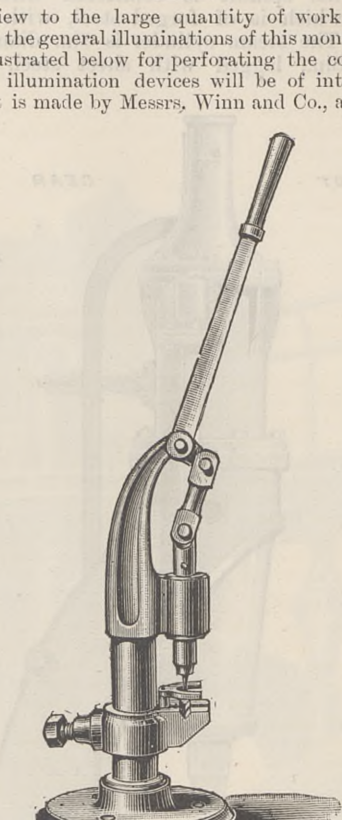
on the pistons and forming pump rams. The wearing surfaces are of large area, and all parts are readily accessible, and of extra strength to resist rough usage. This pump is made to pump against a head of 400ft.

The ordinary commercial crab now so largely manufactured has many defects which become serious and important under the obligations imposed upon users by the Employers' Liability Act, whereby they are made responsible for the defects of the appliances provided by them for the use of their workmen. The safe working loads of such crabs is always a matter of doubt and uncertainty due to the system which gives the load a crab will lift. In addition to this objection to the lifting crab as ordinarily made, the inconvenience and expense involved in transit have always been great. All the working parts being rigidly keyed and secured a skilled workman is required both to take it to pieces and to fit together again. This causes it to be invariably shipped in a complete form, taking up much room and increasing the cost of freight. The Mark's crab, illustrated on page 442, and exhibited by Messrs. Tangye, has been designed to obviate the foregoing disadvantages, at the same time possessing several other novel features. Its main parts are so arranged that rough usage cannot weaken them, whilst the simplicity of construction is such, there being no keys, pins, bolts, or cotters to remove, that one man with an ordinary spanner can take the crab completely to pieces and put it together again in remarkably short time. One of the crabs has actually been taken entirely to pieces in less than five minutes. The load each crab is absolutely safe to lift direct from the barrel is plainly indicated by lettering cast on the sides. Speed and safety in lowering are obtained by the same movement of one hand lever causing the ratchet to be released and the brake to be applied, thus obviating the dangerous arrangement of the ordinary crab which compels the workmen to raise the ratchet with his fingers while the load is suspended from the barrel.

We have now noticed all that most deserves attention among Messrs. Tangye's exhibits; but we have by no means mentioned all the varied products of the firm, specimens of which they show, and all of which are more or less well known to our readers.

GAS-PIPE PIERCING MACHINE.

WITH a view to the large quantity of work which will be required for the general illuminations of this month, the piercing machine illustrated below for perforating the copper tubes for making gas illumination devices will be of interest to many readers. It is made by Messrs. Winn and Co., and is not only



a labour-saving, but what is more important in these matters, a time-saving contrivance. The holes made by it are, moreover, regular in size, and are all pierced straight and true.

THE INSTITUTION OF CIVIL ENGINEERS.

ACCIDENTS IN MINES.—PART I.

AT the concluding ordinary meeting of the Session 1886-87, held on Tuesday, the 24th of May, Mr. Edward Woods, the President, being in the chair, the paper read was on "Accidents in Mines," Part I., by Sir Frederick Augustus Abel, C.B., D.C.L., F.R.S., Hon. M. Inst. C.E.

Since 1835 a succession of Royal Commissions and of Parliamentary Committees had collected and weighed the results of experience, and the views and opinions of miners, mine-managers, and scientific experts, and as a result much improvement had taken place in the working, management, and supervision of mines. But within the last ten years it had been warmly maintained, by competent authority, that the benefits which should accrue from the existing laws were far from being fully realised, while further and more stringent legislation was urgently needed in several directions. In Parliamentary debates great stress had been laid upon the lamentable loss of life due to explosions in mines, but it was scarcely realised that certain causes of accident, which attracted but little public attention, gave rise year after year to a proportion of deaths far exceeding that due to explosions. In support of these opinions, due to the late Mr. Alexander Macdonald, M.P., the author submitted a table, compiled from the annual reports of the Mine-Inspectors for the years 1875 to 1885 inclusive, from which it appeared that, out of 12,315 deaths, only 23·57 per cent. arose from explosions of firedamp, while 40·77 per cent. were due to falls of roof and sides of mine-workings, the remaining 35·66 per cent. being the results of miscellaneous accidents. Moreover, the percentage of deaths due to explosions was very fluctuating, specially heavy mortality having been caused by particularly calamitous explosions in certain years; while, on the other hand, the loss of life caused by falls of roof and sides was not only almost always higher than that due to explosions, but it was also nearly constant. As a result of a debate in the House of Commons, in June, 1878, in which these facts were prominently put forward, a Royal Commission was appointed to enquire into the subject of accidents in mines. The final report of this Commission was published in March, 1886, and during the seven years of its existence the scientific section of the Commission, of which the author was a member, had been almost continuously engaged in examining and experimenting with various appliances for ensuring the safe conduct of mining operations, and much original investigation had been entered upon, the results of which were given in the paper.

As an instance of the smaller classes of preventible accidents in mines, due to modes of working, reference was made to the custom prevailing in South Wales, of allowing boys to run in advance of the horses and trams used for haulage for the purpose of opening and closing the air-doors. It had been frequently pointed out that the danger arising from this custom would be obviated if boys were stationed at the air-doors, instead of being allowed to run with the trams. The class of accidents connected with the shafts of a mine appeared to have been successfully grappled with. The first "safety-cage" which came before the public prominently was that of Mr. Fourdrinier, to whom a medal was awarded in 1851. Since that time various improvements had been made in this adjunct of the mine, particulars of which were given, as were also details of various safety-hooks for preventing over-winding.

The sudden yielding or dislodgment of the roof or sides of a working was a fruitful source of accident, and the variable conditions under which such movements occurred presented a formidable obstacle to anything approaching a trustworthy comparison of the different systems practised in different coalfields for coping with this danger. The employment of cast and wrought iron and cast steel in place of, or in combination with, timber for propping and securing workings, had found favour here and there, but had not been largely substituted for ordinary timbering and arching. In workings where powder and certain substitutes for blasting could not be employed with advantage, and where, therefore, mechanical appliances had to be used for bringing down the coal and stone, the risk of accidents from falls would obviously be reduced by reason of the increase of the ratio of work done to the time spent by the men in close proximity to the working-face. Several of these mechanical processes for getting coal were referred to, as was also the application of compressed air for the same purpose by the Dubois and François method, employed in some Belgian coal-mines, and by the English and Beaumont tunnelling-machine at the Bridgwater Collieries.

Although the efficient support of the roof and sides, and the increased facilities for the expeditious performance of mechanical work, contributed to the diminution of the death-rate from falls, the miner's vigilance in this respect must often be of little avail if, as was still frequently the case, he was dependent upon a source of light insufficient to enable him to see distinctly the signs of a fall impending in his immediate vicinity. One of the chief, and most laborious, branches of experimental investigation upon which the late Royal Commission entered was the determination, by trustworthy and searching methods of experiment, of the relative merits of the numerous varieties of safety-lamp which had been devised in recent years, and especially since the appointment of that Commission. The author proposed to deal with these experiments and their results in Part II. of his paper; but, in so far as these improved lamps acted as indicators of firedamp, they were described, and the principle upon which this application of some of them were based—namely, the formation of a luminous cap over the flame when placed in an explosive atmosphere—was discussed. Reference was also made to other types of firedamp-indicators, such as those devised by the late Mr. Ansell and others, the preference being given to the instrument of E. H. T. Liveing, as most nearly approaching the fulfilment of the conditions essential in a firedamp indicator.

Some experiments made ten years ago by Mr. H. Hall, Government Inspector of Mines, in different seams of fiery coal, appeared to have afforded conclusive evidence of the considerable extent to which the escape of gas might be increased by the rarefaction of the air upon the face of the coal. Experiments had also been made in a similar direction in a coal-mine belonging to the Archduke Albert, at Karwin, in Austrian Silesia. The Royal Commission carefully examined into the existing information, including the experiments referred to, which bore upon the influence exerted by variations in atmospheric pressure on the conditions of the air in coal-mines where firedamp was prevalent. But although numerous striking instances had occurred of the coincidence of explosions with, or their speedy occurrence after, abnormally rapid barometric depressions, the commissioners deprecated the adoption of any official measures such as the establishment of observatories in mining districts, or the issue of warnings by the Meteorological Office. The opinion was expressed that safety in mines was much more likely to be ensured by the increasing vigilance of the officials and workmen than by encouraging a sense of security, which might be very misleading, as based upon such warnings.

The sudden and violent escape of gas accumulated locally under great pressure was next considered, reference being made to various recorded outbursts of gas in England, and to the remarkable occurrence of natural gas in the petroleum districts of the United States and of the Caucasus. The possibility of taking measures for facilitating the comparatively gradual escape of firedamp from gas-bearing strata, so as to relieve the pressure, had received much serious attention. The driving of bore-holes into the coal in advance of the working face had been attended with good results. Recourse had also been had to bore-holes driven into gas-bearing strata contiguous to mine-workings; but the time and cost of carrying out such operations, to any useful extent in localities where such strata were at a distance from the workings, precluded any considerable extension of this system. In some cases special gas-drains had been provided in connection with goaves and other lurking-places for gas within the mine; in other localities it had been found beneficial to carry an airway along the rise side of the workings. Even well within the experience of existing mining authorities, it was the custom in workings of limited extent to fire periodically the accumulated mixture of gas and air; while so lately as 1879 the practice of keeping open lamps suspended in the higher regions of workings, to burn the firedamp, was recognised by the authorities in Saxony, although this dangerous course had since been prohibited in mines where the safety lamp was prescribed. The late Sir W. Siemens brought under the notice of the Commission an invention of Mr. Körner, of Freiberg, for consuming the firedamp in mines. In consisted of a mass of porous material coated with spongy platinum or palladium at a low red heat by a stream of vapour emitted from a petroleum lamp beneath it, allowing the air charged with firedamp to pass over this species of slow-combustion furnace; but its action was found to be only feeble. Other expedients for removing firedamp had been proposed, chiefly of electrical or chemical nature, but not one of them appeared to be of a practicable character. With regard to the sudden invasion of mine-workings by large volumes of firedamp bursting forth under great pressure, the most that could be hoped for was some reduction in the frequency of such occurrences, and the Royal Commissioners laid stress upon their conviction that the only present safeguard against the possible serious consequences therefrom lay in the provision of ample ventilation.

The author then referred to the varieties of fans and mechanical ventilators now in extensive use, amongst the largest and most effective of which were those of Guibal and of Leeds, working in casings and ranging in dimensions up to 50ft. in diameter; the Waddle and Rammel fans, open at the circumference, and ranging up to 45ft. in diameter; and the quick-running fans of Schiele, up to 15ft. in diameter. In regard to the improvements accomplished in the arrangements for rapidly passing large volumes of air through mines, the method of forcing a single current of air through the ways and leaving ventilation to be accomplished by diffusion had to a large extent given place, and with incalculable benefit, to a division of the air supply into distinct ventilating currents passing along separate districts. The extent to which the air in mines, where firedamp issued from the freshly-cut coal faces, was likely to be contaminated as regarded ventilation, had been carefully considered by Messrs. Atkinson, Mr. Galloway, and others. The inferences to be drawn from the various observations were, that with the improved mine ventilation of the present day, the air, even in fiery mines, could not become dangerously charged with firedamp with the gas which escaped from the freshly-wrought coal, and from the coal faces which were being worked, and that for such a condition of things to arise a sudden and considerable liberation of gas, or some considerable fall of coal or stone, accompanied by a large escape of gas, must occur at or near the working places. The careful examination into the effects produced by explosions in mines had led to a very general realisation of an important element of danger, additional to, and possibly sometimes independent of, the presence of firedamp in the atmosphere of a mine. The discussion of this branch of the subject and of those relating to the employment of explosives in mines, and the illumination of mine-workings, was reserved for the second part of this paper.

ENGINEERING SOCIETY, KING'S COLLEGE, LONDON.—On Tuesday, May 24th, papers were read before this Society by Messrs. R. S. Mytton and V. J. Bonton, A.K.C.; the former on "Locomotives," the latter on "Fire Engines." Mr. Mytton commenced with a general description of locomotives, and then proceeded to a detailed description of Mr. Webb's latest pattern locomotive now at work on the London and North-Western Railway. This locomotive is designed to travel at fifty miles per hour, which it does but no more, and was chosen for description because it tends to show one way in which the compound principle has been applied to the locomotive. In this engine two high-pressure cylinders are used, feeding a low-pressure cylinder at the same time, thus gaining the advantages of coupled engine without the wear and tear of coupling rods. It was then contrasted with the new type of American locomotive, introduced by the "Strong" Locomotive Company, of New York. The principal appliances described by Mr. Bonton in his paper were Merryweather's patent force pumps, steam fire engines and boilers, Shand and Mason's patent steam engines and boilers, Jones and Shirreff's patent rotary steam fire engine, and the leading types of American steam fire engine. The chief respective advantages of Shand and Mason's and Merryweather's engines were mentioned and compared, and Merryweather's floating steam fire engine was described. Chemical fire engines were then dealt with. The paper concluded with a description of various accessories to fire engines. After a vote of thanks to Messrs. Mytton and Bonton the meeting adjourned.

RAILWAY MATTERS.

A RAILWAY to Helston, in connection with the Great Western at Gwinear Road, has been opened for traffic. It is about nine miles in length, and has cost about £100,000, including the land.

THERE is, it is now stated, no foundation for the report that the Bokharans had declined to permit the construction of a railway through their territory. They are declared, on the contrary, to be anxiously awaiting it.

THE Imperial Commission, under the direction of General Paucker, deputed to take over the Transcaspian Railway from the contractors, has presented a report declaring the construction of the line to be perfect in every respect.

THE Kaisar-i-Hind Bridge is now open for traffic. It was opened by the Lieutenant-Governor and a large company of European ladies and gentlemen, and a vast concourse of native spectators, with some Bengal Cavalry, Bengal Infantry, and Punjab Volunteers.

THE directors of the Midland Railway Company have decided to give all the men in their employ a day's holiday on June 21st, allowing them a day's pay therefor in commemoration of the Queen's Jubilee. This will apply to the men all over the line, and those who cannot be spared on the 21st will have another day.

MONDAY, the 20th June, is now named as the day on which the Tay Bridge will be opened for traffic. The work at the bridge is being carried forward with all despatch. Nearly one thousand men are employed, and so anxious are the contractors to have the structure completed for the summer and autumn tourist and other traffic, that the workmen are working overtime.

THE President of the Canadian Pacific Company has recently said that it would be an easy matter for the company to abandon the line west of Sudbury and Nipissing, and send the traffic *viâ* the Sault Ste. Marie line. This, accompanied by the statement that the traffic on the first-mentioned part of the railway does not amount to much, has caused much concern in Ottawa.

IT is stated that a syndicate, composed chiefly of Belgians, has obtained from the Persian Government the concession for constructing the first Persian railway. The first line will run from the capital, Teheran, to the celebrated place of pilgrimage, Shah-Abdul-Azim, a town of 90,000 inhabitants, and it will be about 10 kilometres in length. It is said that the concession granted to this Belgian company has an importance far exceeding any value that can be attached to any single of rail, as it entitles them to the exclusive right of constructing and working a long line from the Caspian Sea to the Persian Gulf.

THE following, by a correspondent writing to the *Times*, is very much to the credit of the London, Chatham, and Dover Railway:—"As complaints are so frequently made against the railway companies at home and abroad, I hope you will allow me to record an instance of prompt attention and courtesy on the part of one of them. While returning from the Continent a fortnight ago my wife lost her watch somewhere between Paris and London. I wrote to the manager of the London, Chatham, and Dover Railway asking him to endeavour to trace it, and offering to pay any expenses to which he might be put. My letter was promptly acknowledged, and in two or three days I received a notice that the watch was in the hands of the Northern of France Railway, and on Friday I received the watch with a letter from the manager of the London, Chatham, and Dover Railway, saying that the only expense he would ask me to pay was 6½d., for postage and registration."

A PORTION of the Blackburn Corporation Tramways, between the railway station, Blackburn, and Church, a distance of four miles, was inspected on Wednesday, the 25th May, 1887, by Major-General Hutchinson, on behalf of the Board of Trade. The tramways were constructed under the superintendence of the borough engineer for Blackburn, Mr. J. B. McCallum, and Mr. W. Lyster Holt, the engineer to the Blackburn Corporation Tramways Company. The line is laid with steel girder rails 88 lb. per yard, and paved throughout with granite setts 5in. deep. The laying commenced on February 25th, 1887, and notwithstanding the inclemency of the weather, the whole was completed by the date of the inspection. It is therefore an instance of how rapidly tramways may occasionally be laid. The line was successfully opened for traffic on Saturday, the 28th May, 1887. The engines have been constructed by Messrs. Green and Son, of Leeds, and the cars by the Ashbury Railway Carriage and Iron Company, of Manchester. These tramways now afford direct commuuication between Blackburn and Accrington, and will eventually be considerably extended, giving great travelling facilities to an immense population.

FOLKESTONE seems to be waking up, and is beginning to kick against the prohibitive tax levied by the South-Eastern Railway Company upon travellers to Folkestone, to which the fares are about three times as much as to any other place in the country. It is stated that the South-Eastern Company pay £25,000 per year to keep the London, Chatham, and Dover Company out, and this has to be paid by the visitors to Folkestone and those who go through. A deputation of residents of Folkestone waited upon Mr. Forbes and Major Dickson, M.P., last week, at the Victoria station of the London, Chatham, and Dover Railway, to urge upon them the desirability of extending the Chatham and Dover Railway, or obtaining running powers over the South-Eastern from Ashford to Folkestone. Mr. J. S. Forbes said that as to the views of the London, Chatham, and Dover Company, he thought they must have been pretty well manifested when they went to Parliament a year or two ago for the purpose of obtaining access to Folkestone by means of a short railway from Kearsney to a convenient place near the Leas; and, of course, if they had then had the sympathy and the support of the people of Folkestone, which they now seemed to have, he had no doubt whatever that the Bill would not have been defeated. The reason why they selected the route mentioned was that it would place Folkestone in communication with all the important places upon the London, Chatham, and Dover Railway. They had, as they knew, no inconsiderable towns in Faversham, Sittingbourne, Chatham, Rochester, Sheerness, &c.; that was why they selected that means of access to Folkestone. However, they were defeated. The Chatham, as they knew, after a great fight with the South-Eastern, got to Maidstone, the market town and the capital of the county so to speak, and thence to Ashford, and then, having got to Ashford, it got a junction with the South-Eastern, but further than that they were denied anything; they were denied running powers into the railway station at Ashford, although they were within a few yards of it. He dared say, however, that the deputation had that morning found it quite possible to come up to London by the London, Chatham, and Dover Railway by walking from one station to the other, but really there was no reason why they should not have come all the way in the same carriages in which they left Folkestone. The line was there, and supposing their partners, the South-Eastern, were were willing to accede to the wishes of the deputation, the whole thing could be done and arranged for the 1st of next month. He believed their estimate for the proposed line was £180,000; but they did not want to fight that matter over again, although at some future time, if they found the present means of getting to Folkestone were not sufficient, they might avail themselves again of the alternative of the present proposals. In conclusion, Mr. Forbes said if the people of Folkestone would, by such an expression of opinion, show the directors of the London, Chatham, and Dover Railway that they were really in earnest, then he might say the London, Chatham, and Dover Railway would themselves go to Parliament and apply for the Bill.

NOTES AND MEMORANDA.

THERE are 13,381 workmen employed in the Spanish iron ore mines, and the total production of iron ore in 1886 was 3,907,266 tons.

THE production of puddled bar in the United Kingdom in 1886 amounted to 1,616,701 tons, which is a decrease of 294,424 tons on the make of the previous year.

THE American steam tonnage registered for foreign trades was 6000 tons less in 1885 than in 1870, and the percentage of American imports carried in American vessels has steadily dwindled from 75·2 per cent. in 1856 to 66·5 in 1860, to 35·6 per cent. in 1870, and 15·98 per cent. in 1886. Even during the civil war it never fell below 27·5 per cent.

SINCE 1882 the decline in prices of copper has been as follows in London:—

1882	£67	per ton.
1883	63¼	,,
1884	54½	,,
1885	44	,,
1886	40¼	,,

The above table shows that the price of copper has, since 1882, receded over 40 per cent., and has thus fallen with the increase in its use for electrical purposes.

A LECTURE experiment on "the Volumetric Relations of Ozone and Oxygen" was recently delivered by W. A. Shenstone and J. Tudor Cundall, before the Chemical Society. Soret and Brodie have shown that if v be the contraction produced on the electrification of a mass of oxygen, then $2v$ will represent the further contraction that will occur on absorbing the ozone formed by means of turpentine. If it be true that ozone completely dissolves in turpentine, this indicates that three measures of oxygen are concerned in the formation of two measures of ozone. The authors described an apparatus which they have constructed for readily exhibiting Soret's observation to a class.

ACCORDING to the official returns of the Luxemburg Chamber of Commerce, there were last year in the Grand Duchy 60 iron mines in activity, producing, with 3025 hands, 2,361,372 tons of oolitic ore similar to that of Cleveland. Of the 21 blast furnaces, 20 were in blast for 797 weeks, producing 400,644 tons of pig iron with 1732 hands. The number of foundries, including that of the new Dudelange Steel Works, is 7, which, with 178 hands, turned out 2585 tons of castings, of which 2141 consisted of columns, floor plates, and parts of engines and machines. The two rolling mills at Luxemburg and Dudelange produced 28,154 tons of finished iron and steel with 401 hands.

A PAPER on "Magnetic Torsion of Iron Wires" was read last week before the Physical Society, by Mr. Shelford Bidwell. This is an account of experiments made on the twisting produced by sending a current along magnetised iron wires, and the author shows that Widemann's explanation of these phenomena—by assuming a difference in molecular friction at the polar and lateral surfaces of magnetised molecules—is unsatisfactory. The wires were magnetised longitudinally by means of a solenoid in the axis of which the wires were suspended. To obtain consistent results it was found necessary to demagnetise the wire between the observations. This is done by reversed currents of gradually decreasing strength, and a simple arrangement of rheostat and commutator devised for this purpose was exhibited.

PROFESSOR WOODWARD, of Washington, declares that in about 2200 years the rock over which the falls flow, at Niagara, will be all worn away. The area of the rock worn away at the Horseshoe Falls, between the years 1842 and 1875 was 18,500 square feet, equal to 0·425 acres; between 1875 and 1886, 60,000 square feet, or 1·37 acres. The main length of the contour of the falls is 2300ft. The time required to recede one mile, if the rate is 2·4ft. per year, is 2200 years. Before this catastrophe is due, doubtless provision will be made to confine the waters of Lake Erie, so that a disastrous inundation will not take place. What wonders will have taken place before the close of these 2200 years. Anyone who has visited Niagara must have noticed that the falls have receded quite a distance from their original starting place. In passing it may be remarked that under the care of the State Niagara Falls is recovering its pristine picturesqueness. The nuisances associated with it have been abolished, and it is now a noble State park.

THE *Landes Zeitung*, the official journal in the annexed provinces of Alsace-Lorraine, publishes the following returns of the census taken there in December, 1885. At that date the total population was 1,564,355, as compared with 1,566,670 in December, 1880, a decrease of 2315 in the five years. Divided according to their nationality, there were, in December, 1885, 1,368,711 natives of Alsace-Lorraine, 151,755 Germans from other parts of the Empire, and 43,829 foreigners, whereas in December, 1880, the natives of Alsace-Lorraine numbered 1,418,025 and the immigrants from Germany only 114,797. Thus, in the course of five years, the native population has decreased by 49,254 inhabitants—25,293 in Lorraine, 13,984 in Lower Alsace, and 9997 in Upper Alsace—while the immigrants from other parts of the Empire had increased by 36,958. The diminution of the native element is due to the ever-increasing emigration of the people, and the *Landes Zeitung* calculates that if the emigration continues at the present rate the native population will have disappeared altogether at the end of twenty-nine years.

THE report of Mr. William Crookes, F.R.S., Mr. William Odling, F.R.S., and Dr. C. Meymott Tidy, on the water supplied to London during April, states that "the proportion of organic matter present in the water has continued uniformly low, though not, indeed, so markedly low as in the previous month's supply. Thus the maximum proportion of organic carbon in any sample of Thames-derived water was ·179 part in 100,000 parts of the water; with a mean of ·162 part in the entire series of samples, as against a mean of ·172 part for the previous three months' supply. One only of the Thames-derived samples had to be recorded as otherwise than clear and bright; but several samples of the East London Company's water, drawn from a stand-pipe in the Commercial-road, were found to be 'very slightly turbid' from the presence of finely-suspended mineral matter, apparently detached from the lining deposit of the mains in that neighbourhood by exceptional flushings to which they had been subjected. The maximum proportion of organic carbon found in this company's supply was ·147 part in 100,000 parts of water," or one grain in 700,000 grains, or one lb. in 312·5 tons.

AT a recent meeting of the Chemical Society a paper was read on "Ozone from Pure Oxygen," by W. A. Shenstone and J. Tudor Cundall. The authors describe an apparatus in which oxygen has been prepared and stored without the possibility of air gaining admittance. So far as it is possible to determine the purity of the gas by tests, it would appear certain that it has contained at most $\frac{1}{5000}$ of nitrogen. The oxygen has been collected and sealed up in glass tubes containing phosphoric oxide, in contact with which it has been kept for periods ranging from eight weeks to eight months. Subsequently it has been submitted to the action of electricity, and the ozone produced has been measured. In one experiment made at 10 deg. C. no less than 11·7 per cent. of the oxygen taken was converted into ozone. This is a very considerably higher proportion than has been obtained either by Brodie or by the authors from ordinary oxygen when similar means of electrification are employed, but not so high as was obtained by Andrews and Tait, who, however, worked in a different way, and the exact value of whose results is uncertain in consequence of the tendency of the sulphuric acid that they used in their gauges to absorb ozone.

MISCELLANEA.

LAST Sunday afternoon, at 3.30, a tremendous earthslip occurred from a mountain called the Spitze, 2435 metres high, in the Schächenthal, canton of Uri. Two houses with nine persons were buried. Fortunately that part of the valley is sparsely inhabited, otherwise the loss of life would have been considerable. These Swiss mountains appear to be much dissatisfied with their elevated positions.

THE grain porters at Avonmouth Docks, Bristol, have struck work because the stevedores, for the purpose of facilitating the rapid discharge of the steamer Warwick, erected an elevator capable of lifting 50 tons per hour. Thereupon the whole of the grain porters employed at the docks struck work, and said they would remain out until the objectionable machine had been removed. The stevedores telegraphed to Liverpool for men.

THE Belgian Society of Engineers has opened, in the Brussels Bourse, its fifth special exhibition, viz., of building materials excluding metals. An interesting exhibit is that of the Brussels Natural History Museum, consisting of thin plates of all the Belgian marbles, ground down to one-tenth of a millimetre, so as to be translucent, and secured between two glass plates, like preparations for the microscope, so that their structure can be examined with a magnifying glass.

MESSRS. HARTLEY AND SUGDEN, Halifax, have been awarded a gold and bronze medal by the International Horticultural Exhibition held this month at Dresden, Saxony, and the Russian Imperial Horticultural Society, of Riga, have voluntarily awarded a special silver medal for their hot-water boilers for horticultural purposes. These medals make up a total number of thirty-three gold, silver, and bronze medals and awards gained by Messrs. Hartley and Sugden at various International Exhibitions.

A SINGULAR accident took place last week at the works of Messrs. Wilsons, Pease, and Co., of Middlesbrough. One of the calcining kilns, in a row containing seventy, suddenly burst with a loud report, pouring its contents, consisting of hot ironstone, upon the floor below. A workman who was engaged near was unfortunately struck and killed. The kiln was cased with wrought iron plating, and it must have been internal pressure from some unknown cause which caused it to give way. Nothing of the kind has ever before occurred in the Cleveland district.

THE Council of the Gas Institute report that at the last annual general meeting there were elected twenty new members, while four associates were transferred to the class of members, and fourteen to the newly-created class of associate members. On the other hand, there has been a reduction during the year just ended, attributable to deaths, withdrawals, and removals, of forty-seven. This shows a net decrease of twenty-nine, probably attributable in part to the increase in the rate of subscriptions.

THERE ought to be an important trade in coffee mills, for it is estimated that the total production of coffee in the world is about 600,000 to 650,000 tons, of which Brazil alone produces between 340,000 and 380,000 tons, and Java 60,000 to 90,000 tons, the proportion of British-grown coffee being only about 35,000 tons, of which India contributes 15,000 to 18,000 tons, Ceylon 10,000 to 12,000 tons, and Jamaica 4000 to 5000 tons. Although numerically very small, the productions of British Colonies and of India occupy the front rank owing to their excellence.

AT a meeting of the Walsall Chamber of Commerce last week, Mr. F. James presiding, it was reported that fifteen letters having been distributed amongst the trade with reference to the publication of the prices of accepted Government contracts, only five replies had been received, of which three were strongly deprecatory of the proposal, and two were in favour of the prices being made known. After some discussion it was resolved to inform the Contract Department at Woolwich that while those who were inside—the contractors—condemned the publication of contract prices, those who were outside wished to know what was going on.

MUCH interest has been aroused amongst iron and steelmasters by Mr. Percy C. Gilchrist's paper at the Iron and Steel Institute meeting upon basic slag as a manure. The efforts of the Staffordshire Steel and Ingot Iron Company at Bilston to utilise its slag by reducing it to a fertiliser by means of machinery are, we understand, proving very successful. It is stated that the whole of the make has been contracted for by the artificial manure company. The company remarks that Mr. Gilchrist was perfectly correct in laying much stress upon the importance of reducing the slag to extreme fineness. The fertiliser which is now being manufactured at Bilston will pass through a mesh of 10,000 holes to the square inch. Additional grinding machine plant will by-and-bye be erected.

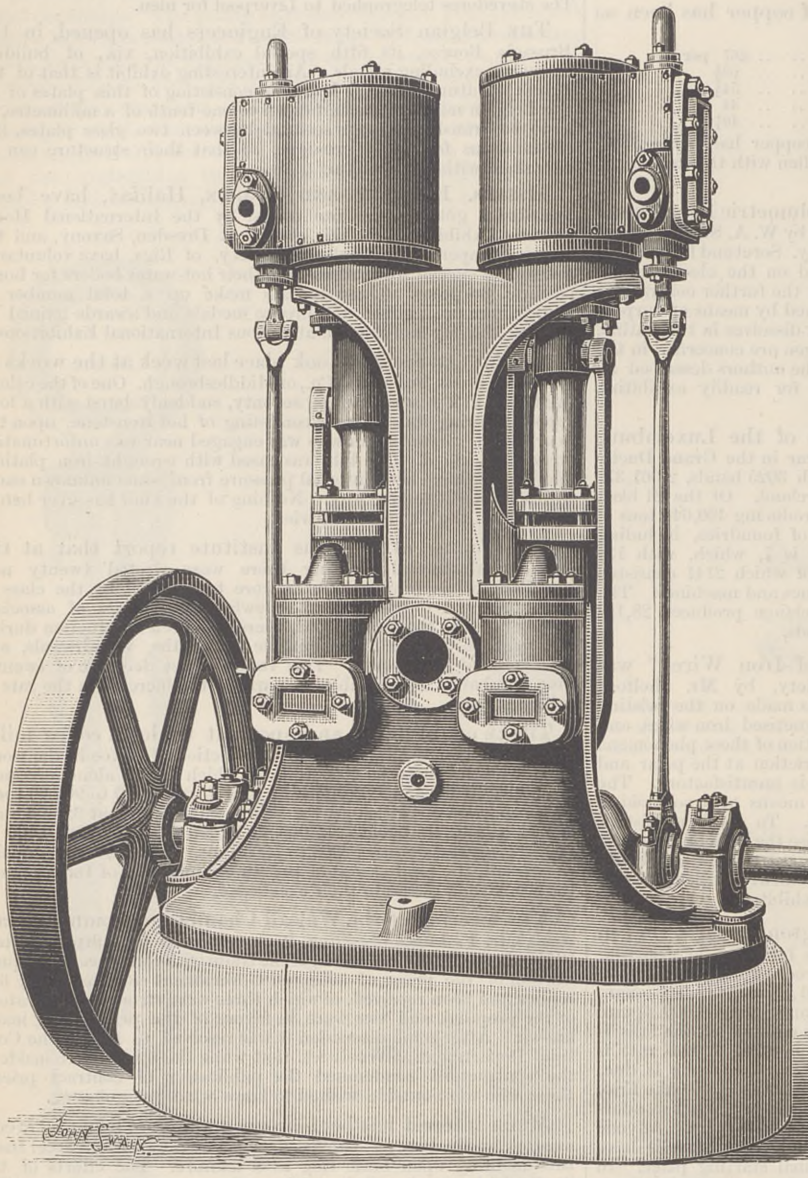
MR. ADAMS, of Hill of Beath, Dunfermline, who has carried on mining operations at Hill of Beath for many years, recently obtained a lease of the minerals on the estate of Dalbeath, and he has commenced sinking operations in the new field on a scale which promises to rival anything in Fifeshire. The site of the operations is about a mile from Mr. Adams' works at Hill of Beath, and the shaft in process of sinking measures 25ft. by 10ft. The shaft is surrounded by troppean rocks, and it is anticipated that the water supply will be heavy. To meet the water supply, a direct working compound engine is being erected, which, it is calculated, will be able, if necessary, to raise a ton of water to the surface every stroke. The machinery is being supplied by Grant and Ritchie, Kilmarnock, and six large double-flued Lancashire boilers, by which the steam is to be supplied to all the engines, have been supplied by Mr. W. Wilson, Lilybank Works, Glasgow. It is expected that the "Dunfermline splint" seam will be struck in the shaft at a depth of 180 fathoms. It would be difficult to estimate the cost of the fittings of the pit, but the total outlay for machinery will be at least £10,000, and ere the coal has been opened up the expenditure may not be less than £30,000. The whole work is being carried out under the immediate superintendence of Mr. David Adams.

THE R.M.S. Trojan, built and engined by Messrs. J. and G. Thomson, of Clydebank, Glasgow, for the Union Steamship Company's Cape of Good Hope mail service, has had her engines converted from the compound to the tri-compound system by Messrs. T. Richardson and Sons, of Hartlepool, and has been supplied with new boilers working at a pressure of 160 lb. per square inch. The diameters of the new cylinders are 34in., 54in., and 89in. respectively, and the length of the stroke 60in. The Trojan went out for her trial trip at Stokes Bay on Saturday, May 28th. She attained a mean speed of 13·9 knots per hour, and indicated 4092-horse power, her engines working at 66 revolutions per minute, with a steam pressure of 160 lb. to the square inch. This shows an additional 530 indicated horse-power, as compared with the Trojan's trial trip with the compound engines. The adoption of the triple-expansion engines will add greatly to the comfort of passengers, through the decreased vibration, while the economised consumption of coal will be advantageous to the proprietors. The Trojan is the third of the Union Company's mail steamers which has been converted to the new system, and it is confidently anticipated that the result will be as satisfactory as in the case of the two others—viz., Spartan and Athenian. The Mexican is now having her engines tripled, and will be followed on her completion by the Moor. The inter-colonial steamers Anglian and African are also fitted with triple-expansion engines. Whilst the Trojan's engines were being altered advantage was taken of the opportunity to fit her with one of Messrs. J. and E. Hall's refrigerating machines, whereby a constant supply of ice will be provided, and fresh meat, provisions, &c., for the use of passengers, obtained in England, will be preserved throughout the voyage. The Trojan sailed from Southampton for the Cape of Good Hope on June 2nd.

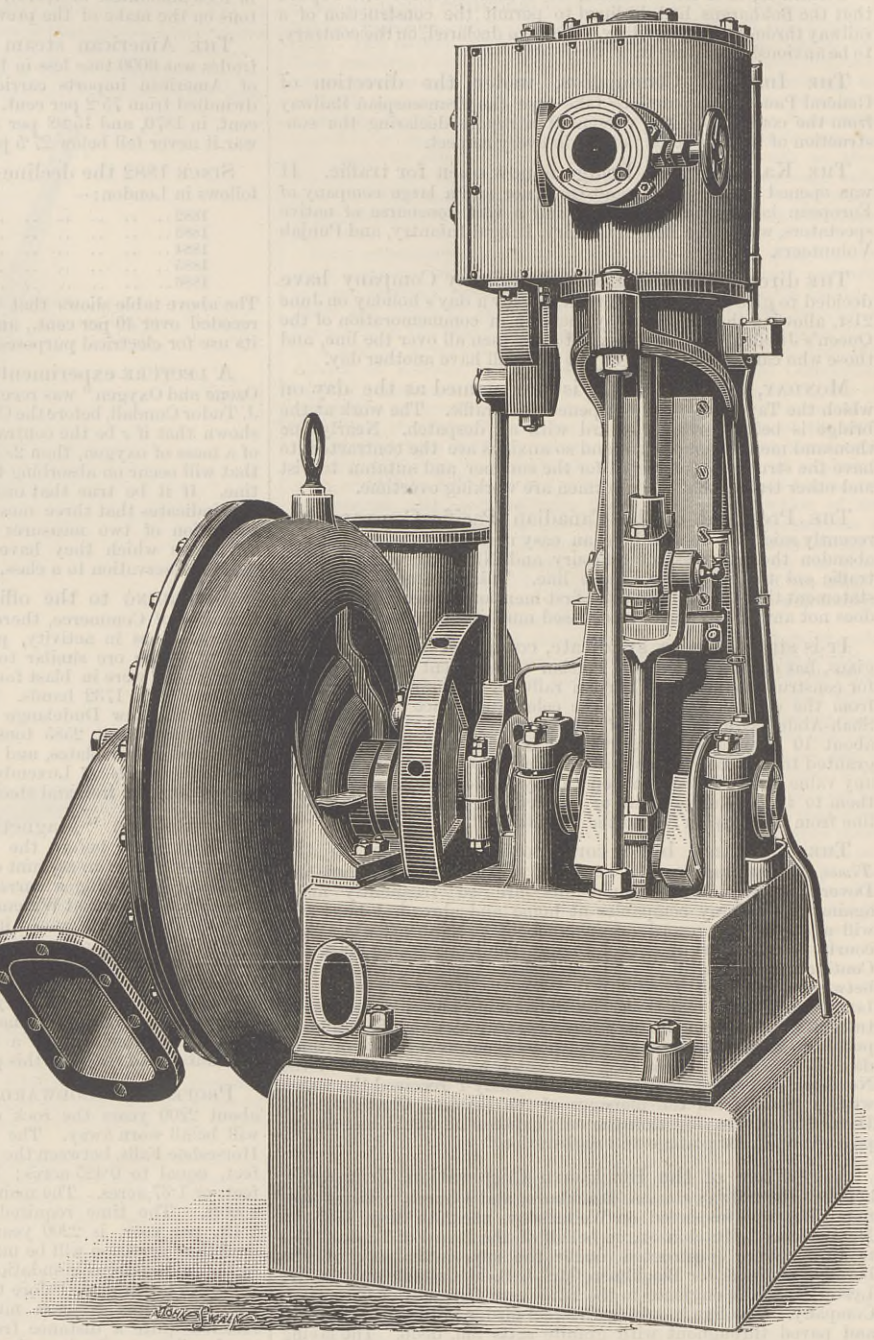
MACHINERY AT THE MANCHESTER EXHIBITION.

MESSRS. TANGYES, BIRMINGHAM, ENGINEERS.

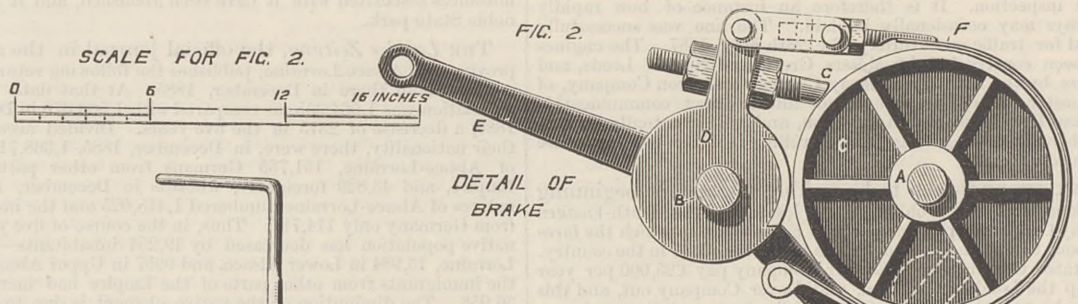
(*For description see page 439.*)

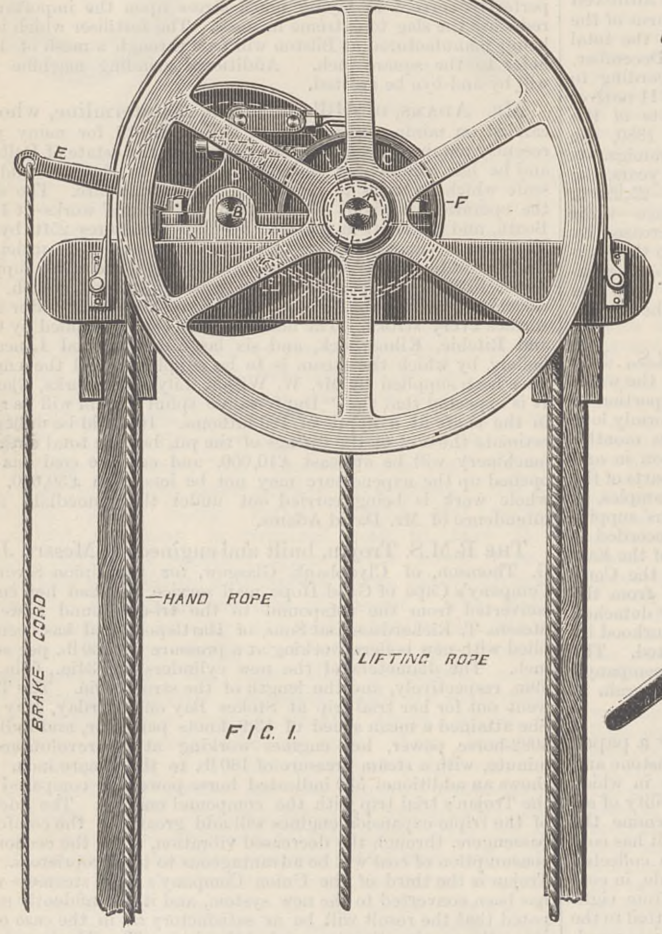


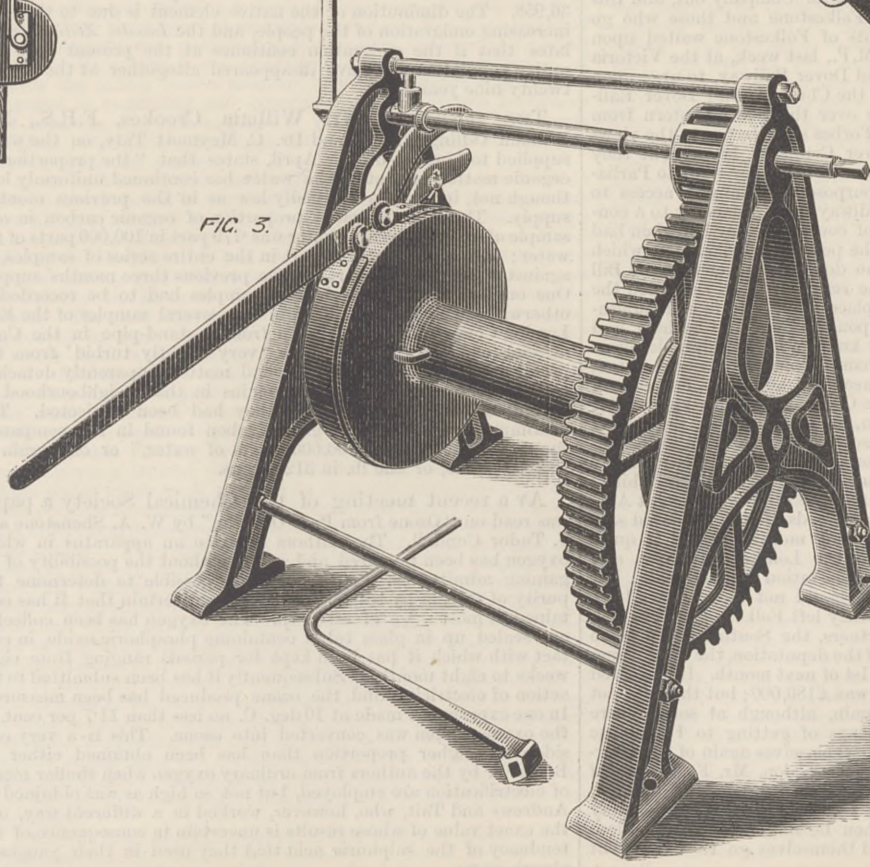
HIGH LIFT COLONIAL PUMP.



CIRCULATING PUMP.



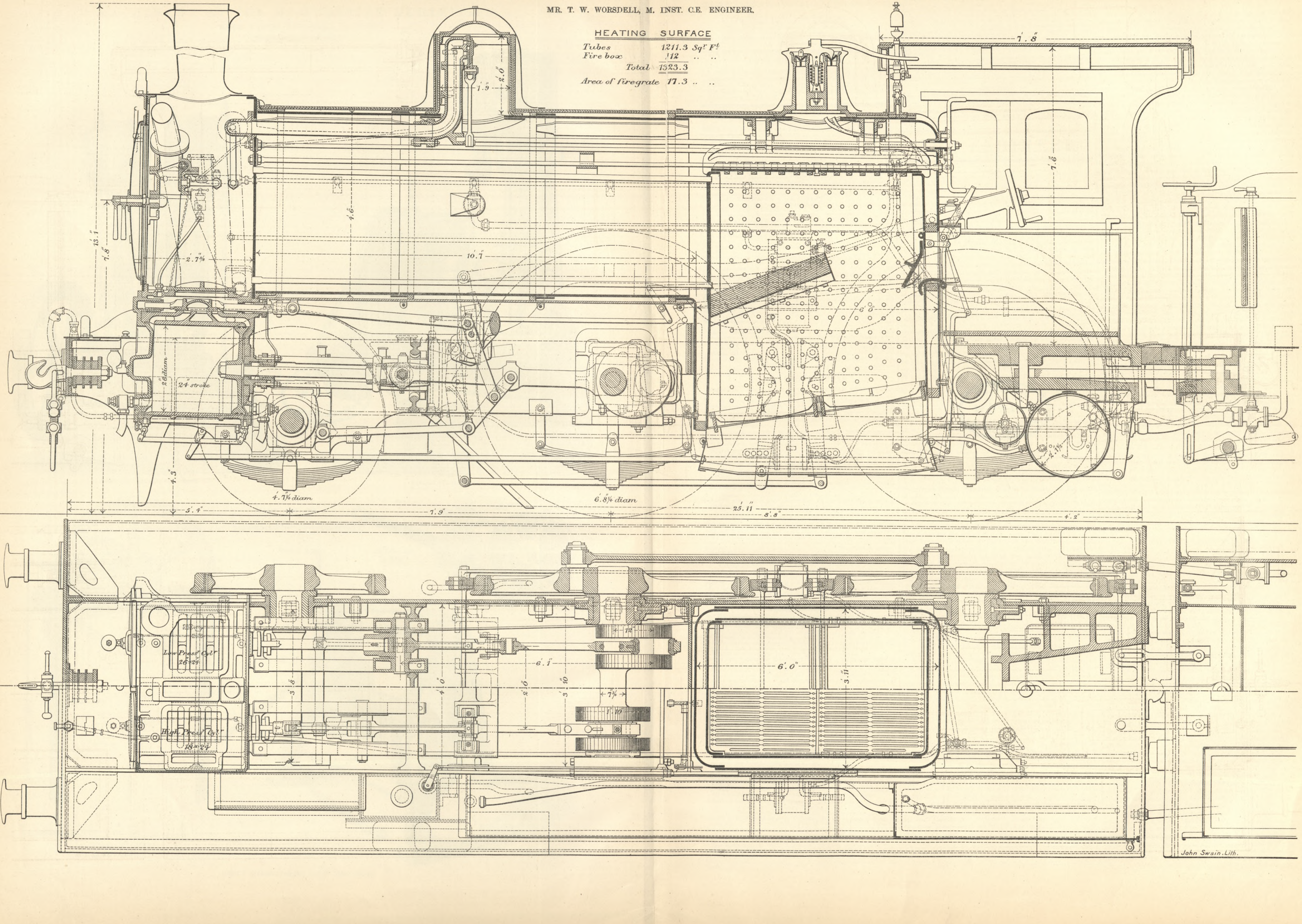




MARK'S SELF-SUSTAINING HOIST AND CRAB.

COMPOUND PASSENGER ENGINE—NORTH-EASTERN RAILWAY.

MR. T. W. WORSDELL, M. INST. C.E. ENGINEER.



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*** *With this week's number is issued as a Supplement a Two-page Engraving of a Compound Passenger Engine—North-Eastern Railway. Every copy as issued by the Publisher contains this Supplement, and subscribers are requested to notify the fact should they not receive it.*

CONTENTS.

TO CORRESPONDENTS.

Registered Telegraphic Address "ENGINEER NEWSPAPER, LONDON."

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C. N. (Messina-avenue).—*You cannot do better than advertise.*

R. S.—*The statement is simply incredible—the result, no doubt, of want of accuracy on the part of the experimenter.*

HEATING COCKLES.

(To the Editor of The Engineer.)

SIR,—Will any of your readers kindly say what is the best shape for a cockle, for heating by hot air, through 9in. cast iron pipes already laid, a large drying laundry; and whether wrought or cast iron would be most durable?

CONSTANT READER.

May 30th.

SULPHUR REFINING PLANT.

(To the Editor of The Engineer.)

SIR,—We have an inquiry from a foreign correspondent for a small plant for making and refining sulphur from iron pyrites, and we shall feel obliged if any reader will inform us where we can best get the information required, and who are the makers of the machinery.

May 30th. C. AND R.

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MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS, 25, Great George-street, Westminster, S.W.—Tuesday, June 7th, at 8 p.m.: Annual general meeting, to consider the report of the Council on the state of the Institution, to elect a President and Council, and to appoint two auditors for the Session 1887-88.

SOCIETY OF ENGINEERS.—Monday, June 6, at the Westminster Town Hall: Ordinary meeting. Paper to be read: —"Renewal of Roof over Departure Platform at King's Cross Terminus, G.N.R.," by R. M. Bancroft, of which the following is a synopsis:—Construction of original laminated timber roof, erected in 1851-2—Cause of its decay—Construction and working of movable staging, so as not to interfere with passenger traffic—Construction and erection of new wrought iron ribs, lattice and trussed purlins—Comparison of weights of old timber and new iron rib—Total weight of ironwork in the roof. The contract drawings, kindly lent by Mr. Richard Johnson, M. Inst. C.E., will be open for inspection.

GEOLOGISTS' ASSOCIATION.—Saturday, June 4th, excursion to Rickmansworth, leaving Euston at 2.15. Saturday, June 11th, excursion to Aylesbury, leaving Euston at 11 a.m.

DEATHS.

On the 24th inst., at Ashfield, Chepstow, ALFRED WILLIAM GOOCH, C.E., third son of Sir Daniel Gooch, Bart., of Clewer Park, Windsor, aged 41.

On the 26th inst., at 45, Fentiman-road, S.W., of apoplexy, after four days' illness, EDWARD BATES, Asse. Inst. C.E. Friends will kindly accept this intimation.

THE ENGINEER.

JUNE 3, 1887.

HIGH-PRESSURE AT SEA.

MANY competent engineers are now advocating the use of steam of 200 lb. or even 250 lb. pressure with triple or quadruple expansion engines. If the latter pressure be employed it is almost, though not quite, certain that four, cylinder engines must be used. The best arrangement in that case, as far as efficiency is concerned, will be that with four cranks equally divided at 90 deg. round the shaft, the two central cranks facing each other, and the two end cranks also being opposed. In this way the main bearings will be relieved of a great deal of strain for reasons quite obvious and well understood. Although the use of large measures of expansion has not been attended with economy in single cylinders, the case is altered when several cylinders are used. The reason why is, however, not fully understood, and we may be excused therefore, if we repeat what we have already said on the subject. In other words, the commonly received theory is, that the use of many cylinders limits the range of temperature in each, and so prevents cylinder condensation. This theory has little to support it. It is based on pure assumption from beginning to end, and its advocates overlook the fact that the entire range of temperature in the engine, as a whole, is the same, whether one cylinder or many be used, while the surface to be heated and cooled is very much augmented in the compound as compared with the simple engine. The truth is, that the reason why the multi-cylinder engine is more economical than the single cylinder engine must be sought in another direction. Let us see what takes place in both types of steam machinery.

In the single cylinder engine some of the steam as it enters from the boiler is condensed; a portion of the resulting water is re-evaporated after the steam valve has closed, and some work is done by the resulting steam; but during the return stroke, when the interior of the cylinder is in free communication with the condenser, a much larger quantity of moisture is reconverted into steam, which steam does no work and carries away a great deal of heat, the whole of which has to be resupplied by the fresh steam entering from the boiler at the next stroke. To use Mr. Isherwood's words, a certain percentage of the feed-water is evaporated twice, at the cost of the coal burned in the boiler furnaces. It is evaporated once in the boiler and once in the cylinder. As has been shown by Mr. Anderson, the re-evaporation which takes place during the steam stroke does not represent much loss, because it keeps up the toe of the diagram; but the far larger re-evaporation which takes place during the exhaust stroke results in dead loss, because the steam so produced does no work whatever. We may compare this action in a single cylinder with what takes place in the high-pressure cylinder of a compound engine. Steam is condensed in the cylinder at first; during expansion it is re-evaporated, the action being in all respects the same, so far, as that just described. When the exhaust valve opens, the pressure drops at once to that in the intermediate receiver, and re-evaporation instantly takes place, at the cost of the heat in the cylinder walls; but the steam so produced, instead of being wasted, is not only utilised, but is utilised with great economy in the second cylinder. If, now, three cylinders are used, the operations performed in the first and second cylinders will be repeated in the second and third. In few words, the economy of the compound engine is mainly due to the utilisation in a second cylinder of the steam made in the first cylinder during the exhaust stroke. Of course there is a secondary cause of economy—namely, that due to the employment of large measures of expansion—which is only rendered possible, however, by reason of the utilisation of what we may term the product of re-evaporation. There are certain small tertiary influences at work, some favouring and some inimical to economy, but of these it is not necessary to speak.

Experience has shown that it is not economical to expand steam in any engine to a pressure of less than 7 lb. or 8 lb. absolute. The lesser limit is perhaps too low, as to attain it the dimensions of the engine for a given power must be augmented, which is very objectionable on the score of weight, expense, &c.; and besides, there is no economy in merely providing power to overcome the engine friction and no more. Taking 10 lb. as the proposed limit, it will be seen that steam of 250 lb. pressure must be expanded twenty-five times to get down to it. Taking the condenser temperature at 140, the thermal limits between which the engine would work would be 406 and 140, and the efficiency of the machine would be, by the well-known formula, $\frac{T - t}{T}$, $\frac{(406 + 461) - (140 + 461)}{(406 + 461)} = \cdot 307$, very nearly—a result, however, so high that we doubt if it has ever been fully realised in practice.

It is one thing to suggest the use of steam of 250 lb. pressure, and quite another to put the suggestion into shape. It is well known that very great difficulties are experienced in dealing with steam of excessively high temperatures and pressures. For one thing, it seems to exert some peculiar solvent action on cast iron, similar in certain respects to that set up by superheated steam, which has been known so to alter the nature of a cast iron slide valve that the metal could be cut almost like plumbago, while long before this stage had been reached the sharp edges of the ports, had completely disappeared. In the case of the quadruple engine, however, it must not be forgotten that the whole of the trouble will be concentrated in a single and comparatively small cylinder, because, in it, and in it alone, will the high-pressure exist. Let us take, for example, a triple expansion engine with cylinders in the ratio of 17in., 25in., and 38in. in diameter. We have here only a very small cylinder to deal with, and such an engine with 120 lb. pressure ought readily to indicate 1000-horse power. If a fourth cylinder were added, and the pressure doubled, it is easy to see that the new cylinder need not be more than 13in. in diameter, and this becomes a very small affair indeed. This being the case, exceptional methods and materials of construction become available for it, and it is worth consideration whether it would not be better to reject cast iron altogether for it in favour of some of the alloys—such, for example, as gun metal, which is known to work very well at high temperatures and pressures in slide valves and port faces. Steel liners have been tried, but the results obtained have not been satisfactory. They were found to be liable to crack, and we are not aware that any engines are now running at sea with steel liners in the high-pressure cylinder. If they are, the engines are of recent construction. There is no reason, however, why, because steel failed some years ago it should fail now. Great advances have been made in the art of working steel, and what will answer well in a gun chase ought also to answer as a cylinder liner. We suggest steel, because so far as is known, high-pressure steam has not the same deleterious effect that it has on cast iron. Piston valves must of necessity be used, because no one has yet succeeded in producing slide valves, balanced or not, which will endure a pressure of anything like 250 lb. Metallic stuffing box packing must be used. In this there is no difficulty.

Putting the question of boilers on one side for the moment, we venture to assert, the present state of the mechanical arts is such that pressures of 250 lb. may be adopted with safety and economy, provided the initial cylinder is treated specially. If, however, it is regarded as one with the rest of the engine, disappointment and loss will certainly ensue. What is good enough for 150 lb. is not good enough for 250 lb. The first, or high-pressure engine, as we may call it, of a quadruple engine, must of necessity be treated on its own merits. It will in all cases, as we have said, be a very small affair, as regards the cylinder, piston, &c., but it does not follow that it will therefore cost less than the other three engines; on the contrary, it may cost more. It must be regarded as a special thing, working for itself and to itself, and exhausting its steam into an ordinary triple expansion engine. The designing of the initial engine of quadruple engines presents a fine field for engineers. We know of course that there are quadruple engines at sea in which no special treatment has been given to the initial cylinder, but these engines work at pressures of not more than 150 lb.; and it is more than doubtful if they are any better than triple expansion engines working at the same or somewhat smaller pressures.

AN INDUSTRIAL EXHIBITION IN JAPAN.

AT the time when we in England are experiencing almost a plethora of exhibitions, and when we find a man so eminent as is M. Tisza, the Hungarian Prime Minister, stating to the Diet that the reason his Government had declined to take part in the International Exhibition at Paris is "because the frequent recurrence of International Exhibitions had reduced their economic and industrial importance," the lesson to be learned from the attempt of an Eastern country such as Japan to encourage industrial pursuits among its own people by similar means cannot but be of value. The extreme competition to which English manufacturers are now subjected by the efforts of other European countries has often been discussed, and it would now seem that in another hemisphere altogether, wherein until late years British manufacturers have had an almost exclusive market, they are likely to meet with much successful rivalry by the natives of a country which, although long famed for certain specialities of production, has not hitherto competed with ourselves in a large class of necessaries.

An Industrial Exhibition has recently been opened at Oyeno, in the Japanese Empire. If we are rightly informed, this Exhibition is the first of its kind which has been attempted by the highly imitative and progressive people of that empire. For many years past the schools and workshops of England have been largely attended by Japanese youths, and it was only to be expected that sooner or later the result of such training would make itself apparent. We have not been without ample evidence of the fruition of the intelligent course adopted by the Japanese Government in sending away its youth to profit by the advanced civilisation of the West. Shipbuilding yards and engine shops, locally established and worked almost entirely by Japanese, have for some years been turning out both vessels destined for the mercantile marine and others of a class fitted to take their place in the Imperial Japanese Navy. This now consists of twenty-five men-of-war, thirteen torpedo boats, and nine training and guard ships. The advance made in this respect by Japan has been singularly associated with the most arbitrary restrictive measures over what we in England hold to be the liberty of the subject. Thus, impressed with the advantage of the employment of steamers in the coasting trade, an Imperial edict has forbidden the building of junks above a certain limit of tonnage capacity, a step which, however repulsive to our Western notions, will probably do much to promote advancement in the local building of steamships. We have further evidence of the same progressive spirit in the erection of a fine art museum at Osaka; a manufactory of fine matting to supersede the present crude system of hand labour, the construction of a floating dock for the naval department at Jokosaka, and the connection of the several garrison towns and all police stations by telephone.

But the holding of the Industrial Exhibition to which we now refer indicates a spirit of advance in the minor branches of manufacture which cannot fail to leave its impress on our future export trade to Japan. It is certain, from what a Japanese contemporary reports of this Exhibition, that Sheffield and many other centres of our manufacturing industry will have to regard with some concern the progress made by the people of Japan in certain branches of work of which they have hitherto enjoyed an extensive monopoly. Thus we learn that in this Exhibition are to be seen reproductions, the result of native ingenuity, of English surgical instruments, drawing and optical instruments, iron safes, mirrors, house furniture, boots and shoes, laboratory utensils, glass vessels, and many other items which have hitherto been largely exported by English merchants to Japan. It is said of these facsimilies that they are scarcely, if at all inferior in make and finish to the production of our own factories. Hitherto the steel prepared by the natives has failed to come near the standard reached by ourselves; but the result of this Exhibition goes to prove that it is scarcely likely British pre-eminence in this material will be long maintained. Indeed we know that Eastern nations have long made steel in small quantities of a quality quite rivalling, if not surpassing in some respects the larger outturn among ourselves. There can therefore be no reason why, aided by instruction from the West, this branch of manufacture should not be as successfully competed in by the Japanese as has been the case with other items. When this is accomplished we must necessarily expect to see our own export of steel articles to the extreme East fall off very considerably, even if it be not entirely superseded by native workmanship.

That export has been very seriously handicapped in the past by the conservatism of British manufacturers. They have failed to take due account of the adaptability of their productions to the different conditions which exist between home and local needs. We have before in this journal directed attention to the tools which have formed a regular export from this country to the East. These have varied little in size and form or design from those used by our own workpeople. They are therefore utterly unsuited to the handling of the weaker natives of the orient, and no allowance has been made for the different methods by which its people pursue certain handicrafts in which those tools are used. We may instance the case—and it is one to which particular attention is directed by the *Japan Weekly Mail* in its account of this Exhibition—of the carpenter's trade. In Japan, as indeed throughout the East, the workman of that handicraft pursues his labour on a level with his work, while in Europe he exercises it above it. The plane is drawn towards the workman, as is also the saw. Different forms of tools are therefore required, and the teeth of the saw must be reversed as to their angle compared with European examples. To what purpose therefore is it to send out consignments wholly unfitted for native use? If we are to meet the competition to which it is evident, as the result of this Industrial Exhibition in Japan, we are certain to be exposed in that country, not alone must we continue to excel in the material of our exports, but they must be adapted in character to the methods pursued by its working classes. There is certainly as much to be learned from this initiatory effort of the Japanese to assemble in review their industrial productions as there is from more ambitious efforts of the kind among ourselves.

MINING MACHINERY AND LOSS OF LIFE.

A telling testimony to the value of the improvement of the machinery in our mines is furnished in a table compiled from the reports of the Inspectors of Mines. As our readers are aware, the loss of life in mines is over a period of years tolerably regular in the total, but as over that period the yield of the mines is enlarged, it follows that in proportion to the quantity of minerals produced the loss of life by these mining accidents is less than it was. The loss of life in and about the mines is given under several heads, the loss by explosions and firedamp being stated separately, as is that by accidents in the shafts, whilst there are other divisions. The loss of life in the shafts of the coal mines of the United Kingdom has been ascertained for more than thirty years, and it furnishes the testimony of which we have spoken. In the year 1854 the number of deaths by accidents in the shafts of mines was 290, and it has fallen with some rapidity. In 1864 the number of deaths was 184, in 1874 it had further declined to 154, in 1884 it had declined to 88, and for the year 1886 the number was only 86. But as the number of men in and about the mines had increased in that time, the proportionate loss of life was less. In 1854 there were 1·23 lives lost in the shafts of the mines for every 1000 persons employed in and about the mines, but with a decreased number of lives so lost, and with an increased number of persons employed, the mortality in the shafts had for the past year fallen to 0·16 per thousand persons employed. And a still more striking comparison can be made—that of the proportion of the total loss of life which is supplied by the lives lost by accidents in the shafts. In 1854 the loss of life in the shafts formed 27·8 per cent. of the total loss of life in and about the mines, in 1864 it had fallen to 21·2 per cent., in 1874 it was 14·6 per cent., in 1884 the percentage was 9·3 only, and last year it was 9·0 per cent. Thus the loss of life is now only a third of what it was at the early date given; it is about a seventh in proportion to the number of persons employed in and about the mines, and whilst it was more than a fourth of the total life loss, it is now less than an eleventh part thereof; and an analysis of the manner in which these accidents in the shafts have occurred proves that the decrease has been in all classes of these accidents, in overwinding, falls, breakages of ropes and chains, &c. The old corves have been done away with and cages substituted, the use of detaching hooks of many kinds has lessened the loss of life from overwinding, and some believe that there has been a tendency to reduce the loss in the shaft by the use of those wire ropes against which at the first the men rebelled. Thus the mining engineer has in the course of three decades very greatly reduced the loss of life in mines, and especially in that loss over which he may be said to have the most control. The firedamp explosions are as yet far beyond the control of the engineer, and there are other losses in the mine over which the miners themselves have more control than he has. Shaft accidents may be the result of imperfect machinery, or of the want of caution of those who use it or who traverse the shaft, and the great reduction we have named shows that there has been very great improvement in the machinery used. Mr. Dickinson, in his report a few years ago, remarked on the "skill and care ordinarily exercised" in arrangements as to the shaft machinery, adding that "millions of windings are performed in which the cages run at railway speed, and are started and stopped almost to an inch without any accident occurring." Other inspectors have also shown that the improvement in the shaft machinery has been remarkable; and had there been the same improvement, and the same reduction of the loss of life in other directions, there would have been a lessened death-roll in our mines.

LITERATURE.

A Glance at our Naval Future, 1887.—A. Albini.

Anything written by Admiral Albini on the subject of war ships, would command attention, and it is especially interesting to read the opinions of one who has had so much influence in the decisions arrived at with regard to Italian naval armaments when expressed on the broad features of the question. Admiral Albini's views may be summarised as follows:—A long period of revolutionary progress in naval mechanical appliances, instead of facilitating the solution of the problem of how to arrive at efficiency, has rather complicated it. The maximum power in each respect has been aimed at, and then suddenly some insignificant alternative has been preferred, so that the pigmy is seen contending with the giant, while each naval Power follows a course of its own. Thus, some would at the present moment convert our large ironclads into transports, and develope a system of torpedo warfare. Some would proceed slowly in the same direction, and others would stand still and do nothing in the present condition of uncertainty, which, however, is not safe for long, seeing that it may involve the loss of naval power to a State that is caught asleep. Admiral Albini thinks that the torpedo, in spite of its terrors, is condemned to disappear, or, at all events, to play a very secondary part. It is visible, and it is not invulnerable. Even supposing its powers of destroying ships of war to be very great, it would never take their place, and therefore at any cost ships of war must exist. The torpedo boat will probably grow into the torpedo ship at present, but such ships eventually will not depend on their torpedo armaments, but on heavy guns, the weapons common to large ships. Line-of-battle ships will no more be abolished by torpedoes than whales become extinct from the attacks of sword-fish. Admiral Albini having formerly prophesied successfully both as to torpedoes and the need of secondary armaments to ships, now speaks with the more confidence, stating that naval squadrons will in the future be composed of ships not very dissimilar from each other, like a land force, deriving its power and efficiency from a combination of various groups of each representing a definite speciality of function. At the same time there will always be a preponderance of that element which is most susceptible of developing the greatest intensity of action—like infantry—and ships will vary according to the scope determined on and the measure required by necessity.

"The exigencies of a nation that aspires to maintain the position for which it competes, on the sea, are so complex that they can never be satisfied by an element susceptible of one sole special application, and whatever may be the phase of progress that one special arm may achieve, it would not be possible to dispense with a powerful force of ships of war on the sea, as a squadron could not do without a strong base of infantry, whatever might be the power derived from other concurrent forces." These, and other considerations, would suffice to show that, even "admitting the exaggerated power ascribed by some to torpedoes, they cannot be substituted for ships of war, nor contend with them for the empire of the sea." Such a conclusion is forbidden "by a law of nature, in virtue of which an effect cannot cease so long as the cause lasts. Therefore until the military necessities cease of carrying war to distant places, of blockades, of attacking strong places, and of hindering disembarkation, the absolute necessity still remains of uniting in one vessel velocity, carrying of coal, arms, and materials for defence, elements which all united in one sole structure, inevitably result in a great ship of war." At present, however, Admiral Albini allows that the destructive power of the torpedo calls for the development of means of resisting its attacks at the sacrifice of other power; but this does not mean the abandonment of great ships.

The introduction of novelties has at all times excited the minds of enthusiasts, and seemed to threaten the existence of great ships, for a time suggesting the adoption of small vessels, but eventually the great ships have predominated. With the introduction of steam this was the case. It was thought that fleets of little steamboats, carrying light guns, would crowd round large sailing vessels and destroy them. The same phase was reproduced on the introduction of cannon of 12 tons, bringing in monitors and gunboats of the Staunch type. Great ships eventually received both steam and the heavy guns, and held their place. The Harvey torpedo produced a shorter scare, because it was soon apparent that the danger to assailants would be greater than to the ship attacked. Similar results have attended the introduction of the torpedo. The torpedo boat depends on its invisibility, which is imperfect. Should it remain its present size, it will fail through its vulnerability; should it increase, it will be the victim of its own expansion. It is not formidable by day, and at night very bright light can be thrown round the ships, and thus the torpedo can be discovered and destroyed by machine gun fire, which might be previously so arranged and distributed that pieces already laid might be fired at the spot required. Besides this torpedo nets might be employed. Other means are being also devised of disposing of torpedoes, either singly or in numbers. Torpedoes themselves, however, are not efficient for the defence of ships against an enemy's torpedo attack, seeing that they are deficient in powers of discovery. Torpedo boats moving round a ship at a distance of from 400 m. to 1000 m. would impede its firing, and at 1500 m. the torpedo boat would not be at all effectual as a guard.

The torpedo boat will probably gradually increase in size to fulfil fresh requirements, until it becomes a line-of-battle ship. Admiral Albini considers that torpedo guns will then probably come in. Eventually many powers of a ship will have to be sacrificed, however unwillingly, to means of securing her from sinking, and of retaining her power to perform evolutions. He further suggests that speed will be sacrificed and that armour-plated caissons will be employed in the water. The existence of open water between the guard and the ship appears to be necessary. In addition to loss of speed, probably some armour above water will be sacrificed to obtain better under-water protection. Modern artillery has now practically beaten armour. Guns of 43 cm. (16·9in.) with a projectile energy of 22,000 "dynemodes" are in contemplation, which implies a power of perforating 76 cm. of iron (29·9in.) Any armour may therefore be pierced, and such armour will be in a measure sacrificed to material in a form whereby the safety of the ship may be better furthered. Probably a vertical armour 30 cm. (11·8in.), thick to keep out the fire of the quick-firing 15 cm. (5·9in.) gun will be employed.

Admiral Albini does not expect guns to be dismounted easily, and some risk in war must be run. The tendency is to substitute mechanism for manual work, which will decrease the number of men necessary and tend to diminish the value of machine-gun fire. Large guns, such as the 100-ton piece, Admiral Albini thinks will hold their position in armaments. One blow by such a gun will at times do work beyond the power of a number of lighter pieces. Armour may probably gradually disappear from ships but not from forts. Common shells will probably be much employed against the unarmoured parts of ships, and high-angle fire against horizontal armour, the further development of which is contemplated. The day on which a naval Power gives up heavy guns will initiate her decay of strength and render her powerless against armoured ships. Vessels can certainly be better protected from sinking by horizontal armour than by vertical, since the latter has been quite mastered by modern artillery. Plates 80 cm. (31·5in.) supported on a very strong structure, would be now necessary for vertical protection.

Finally, as to secondary ships, Admiral Albini thinks that fighting power may be sacrificed too far to speed. Arms for conducting a running fight to the best advantage he thinks must be provided. Two 12 cm. (4·7in.) guns at the bows and two at the poop he thinks are needed. Torpedo boats and small vessels to scatter and carry on an attack distributed over a long course he thinks are needed for this class of warfare, and also ships specially adapted to the attack of coast forts. For the latter purpose small gunboats would probably be best suited. Submarine ships threaten vessels with a new danger, but Admiral Albini thinks the difficulties in the way of efficient submarine attack too great to permit of a long future to this class of vessels.

THE SUBMARINE TORPEDO BOAT NORDENFELT.

The Nordenfelt, which recently began what will undoubtedly be a very interesting and brilliant career, by a successful voyage from Barrow-in-Furness to Southampton, during which she overcame great difficulties of wind and weather, passed on the 26th of last month, with flying colours, her first examination before a body of critics composed for the most part of skilled, experienced, scientific officers of both branches of our services. During the two weeks which had gone by since the arrival of the Nordenfelt in the Southampton docks, many changes had been made in her appearance, and a more business-like and formidable-looking engine of war it would be difficult to imagine than she looked when Mr. Nordenfeldt's guests arrived on Thursday morning last week on the landing jetty beside which she lay. For the purposes of her voyage from the north it had been necessary to place on her a mast for signalling and for carrying a light; a strong winch, to which the steel anchor hawser had been attached; hand-steering gear, and a kind of railed-in space for the protection of the officer of the watch and the steersman. One of her funnels had been placed on top of the other, so that she might be enabled to steam easily with one boiler and with natural draught; and many other fittings and furnishings on her top had been necessary for a long sea voyage.

All of these had been removed by the morning of the 26th; the funnels, the only things standing higher than the level of the conning towers, were each placed on their own boilers, steam was up, and all was ready for a trial. Shortly after 11.30 a.m. the visitors arrived from London, Portsmouth, &c. They included, amongst many more, General Nicholson, Inspector-General of Fortifications; General Harding Stewart, General Sir Gerald Graham, V.C., Admiral Morgan Singer, Captain Wilson, V.C., Colonel Luard; and the following colonial representatives—Sir James Garrick, K.C.M.G., Sir James Lorrimer, K.C.M.G., Captain Thomas, Captain Dickson, Captain Whitney, as well as Captain Fane and the Hon. Anthony Dawson. On the arrival of this party at the Nordenfelt's jetty it was very largely augmented by a party of naval critics, amongst whom were Admiral Sir George Willes, Commander-in-Chief at Portsmouth; Captain Seymour, who had arrived in the Fire Queen; Captain Long, H.M.S. Vernon; Captain Domville, H.M.S. Excellent; a large number of officers from H.M.S. Invincible, and a second batch who had been brought down in the torpedo boat No. 23. General Sir George and Lady Willis, accompanied by a staff, were also present, and the number also included Captain Seymour, Captain Harvey, and a group of scientific gentlemen in private clothes. A comfortable ladder had been fitted up, so that the visitors could get on board the Nordenfelt with as little trouble as possible; but as their number was large and the interest of each gentleman very great, a long time was taken up in preliminary inspections.

This is the fourth boat which has been built by Mr. Nordenfelt, but it is by far the largest and most powerful, while in shape it is different from those supplied to the orders of the Greek and Turkish Governments, the latter being pure cigars. The Nordenfelt is a perfect circle at her midship section, and is 12ft. inside diameter. She is a wedge at stem and stern, and is 12ft. deep at both extremities. She is 125ft. long. When acting as a surface boat her displacement is equal to 160 tons, and when fully immersed 245 tons. She is fitted with peculiar engines, the duty of which is only to turn the main driving propeller. They are double compound, that is to say, two pairs of compound engines working directly on to one crank shaft having four cranks; in all things else they are quite distinct. The cylinders are 15½in. and 26½in. diameter, with a stroke of 16in., and will, it is expected, develope about 1200-horse power. Specially patented balanced slide valves are fitted to each cylinder, which valves are driven by Joy's valve gear. A separate pair of engines drives air, circulating, and feed pumps, and there are on board besides these two pairs of sinking engines, two fan engines, and a pair of steering engines. In all there are on board fourteen distinct engines. Steam is supplied by two large marine multitubular boilers, built of steel. They are about 10ft. in diameter, one of them being 20ft. the other 11ft. in length. As the Nordenfelt lay alongside the jetty before her trial began she was drawing about 11ft. 6in. aft and 10ft. forward, leaving about 2ft. of her nose, and only 6in. of her stern out of the water. Immediately in the middle of her length is the entrance to the stoke-hole, through a scuttle some 3ft. in diameter, which is fitted with a heavy steel door having a glass in it, through which light is admitted to the men below. This door is made tight on india-rubber, and fastened down by means of a screw and wheel on the inside, which can be worked by the stokers. Fore and aft of this scuttle are placed the funnels, the bases of which stand about 10in. above the top of the boat, which 10in. represent the total height of the funnels when she is ready to go below. About 30ft. from the stem and stern of the boat are the conning towers, which stand some 2ft. high, and have the same diameter. They are of 1in. steel, and are perfectly impervious to any shot which in warfare would ever be directed against them. These towers are fitted with heavy doors, in which are fixed glass cupolas, just large enough to allow of the captain's head to enter when he wants to manœuvre the vessel. In the forward tower are placed, at the hands of the commander, means of controlling every motion of the boat; of steering her by steam, of giving her enormous buoyancy at a moment's notice, should it be necessary; of ascertaining her depth under the surface, and whether she is horizontal, and of communicating with the engine-room and stoke-hole. The vessel is divided into five general compartments or divisions: (1) The torpedo chamber, fitted with impulse tubes, in which will be placed two torpedoes; (2) the officers' quarters, which are handsomely and comfortably fitted up for four officers; (3) the boiler-room, which contains two boilers, with the stoke-hole between them amidships; (4) the engine-room, which contains the machinery already described; and (5) the men's quarters, cooking galley, stores, &c.

The visitors, having examined every part of the boat, betook themselves on board the steamboat Alexandra, which Mr. Nordenfelt had chartered for their accommodation, and proceeded out of the dock in front of the Nordenfelt. As it was intended to exhibit the latter in a semi-submerged condition, the buoyancy was first reduced by the admission of water into the tanks, the funnels being taken down and passed into the stoke-hole, at the same time the furnace doors being close shut and the fires hermetically closed in. The funnel bases being then closed, and the buoyancy reduced until practically nothing remained above the water save the two conning towers and a few inches of her back, the Nordenfelt steamed out of the docks and proceeded down Southampton water at the rate of about six miles an hour. The neutral tint she was painted rendered her almost invisible at the distance of even a few hundred yards, while as a target she presented nothing to attack save the two conning towers and a few inches of her turtle back, and as these are of great strength, and rendered still more invulnerable by their shape, it is all but certain that no gun carried on any other torpedo boat will ever do her the slightest injury, while she at the same time possesses the enormous advantage of being able to attack without smoke or fire or noise. Indeed, given these advantages of a minimum of target, and a total absence of noise and smoke, we fail to see what more could be desired in any vessel of war. All the officers and scientists on board the Alexandra were unanimous in their admiration of her powers during this trial; and having desired to see her as an ordinary surface boat, they signalled her to that effect. The time occupied by the closed-in trial was about one hour and twenty minutes, but a sufficiency of steam is stored up in the boilers to drive her a distance of about twenty-four miles. The powerful pumps on board were now put in motion, and in eight minutes some twenty tons of water had been pumped out, which gave the vessel about 2ft. freeboard. The funnels being then once more fixed, the fires re-lighted, and fans set away at full speed, steam was very soon showing at 100 lb., and a run was made as far as Calshot Castle and back at about three-quarter speed, the distance being about thirteen miles, and the maximum speed being about 15 knots. Even those on board the Alexandra, who were before doubtful of her value as an engine of submarine warfare, were of opinion that as to her use as an ordinary torpedo boat there could be no doubt of the great advantages she possesses. Her speed was good; indeed, she ran right away from the Alexandra, which is a fast boat. She appeared to be capable of being manœuvred and steered with great ease and certainty, and there is no doubt that she passed torpedo boat No. 23 apparently very easily, though very likely this boat's crew may have acted cautiously, fearing a breakdown, and having nothing to gain by going fast.

In comparing No. 23 and the Nordenfelt from the deck of the Alexandra, one could not fail to be struck by the enormous advantage the submarine possessed over the torpedo boat in point of target; indeed, the submarine was a mere streak on the water, and could not be distinguished at 500 yards, while "23" would have afforded a very considerable target at two miles. It was noticed that when going at a fair speed the bow and stern of the Nordenfelt produced a bow and stern wave, which entirely hid the body of the boat in a hollow, and gave her all the appearance of a submerged boat, leaving only the funnels visible. Looking at the Nordenfelt from the tender, one would suppose that great quantities of water must have been getting on board through the conning towers, which were of necessity open to feed air to the fans; but after the trial we found that only a few drops of spray had got down—not a gallon altogether. As most of the crew were new to the boat, it was not intended to completely submerge her, but only to close her up and sink her till the conning towers were awash, to show how she would work with the bottled-up steam, then to open her up and make a speed run on the surface as an ordinary boat; and this programme having been most satisfactorily carried out, she was once more taken into dock. The temperature on board during the closed run was high, but by no means insufferable; while during surface runs, when the fans are working, it is fresh and cool all over the boat. It may be of interest to mention that the ordinary coal capacity of the Nordenfelt is nearly eight tons, which is sufficient to drive her at a moderate speed—say eight knots—a distance of about 1000 miles. But should it be necessary to transport her to a greater distance, her water tanks can be filled with coal to such an extent as will enable her to face a voyage of 2500 miles. In speaking of the trial of the 26th, the *Army and Navy Gazette* says:—"From this preliminary trial it must be admitted that Mr. Nordenfelt and his capable captain, Mr. Garrett, have got a boat which has a great and assured future before it. Certainly we are not asked to believe anything more than we can see. There is no pretence that the craft will dive like a porpoise, that a man can come out of her and walk on the bottom, or that she can be steered a course under water. That with a gun or two on her turtle back, and working as an above-water torpedo boat, she possesses many advantages over the ordinary first-class boat seems certain, and her powers of submersion when fully established should make her the more valuable craft, the cost being the same. It is not likely or advisable that a number of such boats should be at once built, but the country which can give £100,000 for a Brennan torpedo would do well to further in every possible manner trials and experiments with a boat so simple, yet possessing such possibilities in the future."

THE IRON AND STEEL INSTITUTE.

In our last impression we gave a short account of the proceedings of the Iron and Steel Institute, on Thursday, the 26th ult., at Westminster. To some of the papers referred to as well as one on "The Electro Deposition of Iron," by Professor Chandler Roberts Austen, we may return. The first paper read on Friday was by Mr. James Riley, on "Some Investigations as to the Effects of Different Methods of Treatment of Mild Steel in the Manufacture of Plates." This paper and the discussion upon it occupied the whole morning.

The investigations were intended to elucidate the following:—(1) The effects of different amounts of "work" done on the ingot and slab in making plates; to be shown by using ingots and slabs of different sizes and reducing them to plates of various thicknesses. (2) The comparative results due to "reheating" or "soaking" ingots. (3) The results of "hammering" compared with those due to "cogging" the ingot. (4) The merits of "cross-rolling" as compared with rolling in one direction only. (5) The results due to annealing. (6) Any points worth noting in carrying out a large series of bend tests under different kinds of treatment. To insure uniformity in the steel to be used, the whole of the plates subjected to tests were made from one charge.

A charge of "ship plate" quality, was used; it gave the following results on analysis:—Carbon, ·18; silicon, ·03; sulphur ·04; phosphorus, ·06; manganese, ·48. From this charge the following sized ingots were cast: Two ingots 24in. by 15in. sectional area, two ingots 14in. by 14in., four ingots 18in. by 12in., and four ingots 12in. by 6in., which were treated as follows:—Two ingots 24in. by 15in.: (1*a*) Reheated and hammered to six slabs 8in. thick; (1*b*) soaked and hammered to six slabs 8in. thick. Two ingots 14in. by 14in.: (2*a*) Reheated and hammered to six slabs 8in. thick; (2*b*) soaked and hammered to six slabs 8in. thick. (One set of each of these slabs was rolled into plates 1in., ½in., and ¼in. thick respectively; rolling being in one direction, lengthwise of ingot. The second set was rolled to plates of same thickness as those above, but in two directions; first across the slab, then lengthwise.) Four ingots 18in. by 12in.: (3*a*) Reheated and hammered; (3*b*) soaked and hammered; (3*c*) reheated and cogged; (3*d*) soaked and cogged. From each ingot three slabs 8in. thick and three slabs 4in. thick were made. (These slabs were rolled to 1in., ½in., and ¼in. plates respectively, being cross rolled as usual.) Four ingots 12in. by 6in.: (4*a*) Two ingots reheated and hammered; (4*b*) two ingots reheated and cogged. From each two ingots three slabs 4in. thick. (Rolled to 1in., ½in., and ¼in. plates, cross rolling as usual.) The slabs from the two ingots 14in. by 14in., and the four ingots 12in. by 6in., were not worked on edge, the others were. From the plates rolled as described test-pieces were sheared off. Thus there were rolled in all fifty-four plates from this charge, and as eight tensile tests were made from each plate, the total of these tests was 432. The number of bend tests was nearly 1300. The averages of the results of these tests were given in a series of tables, representing them as relating to—(1) Reheating *v.* soaking; (2) hammering *v.* cogging; (3) cross-rolling *v.* rolled in one direction only; (4) results due to different amounts of work. Concerning these results, and (1) as regards the comparative effects of "reheating" and "soaking" ingots, the tests of plates 1in. thick show those made from soaked ingots to be clearly superior in ductility, whether annealed or unannealed, whether taken lengthwise or crosswise of the plate. The ½in. plates show a slight superiority in ductility for the soaked ingot. The ¼in. plates invert the order, and give the superiority in ductility for the reheated ingot. In all cases the reheated ingot gives a slightly higher breaking strength. The 1in. plates show strength and ductility, both slightly in favour of the reheated ingot. The ½in. and ¼in. plates show an equality on all points between the two methods of treatment. The 1in. plates from hammered ingots give the strength about equal to, and the ductility in favour of, soaking. The 1in. plates from cogged ingots give the strength in favour of soaking, while the ductility is clearly in favour of reheating. In the ½in. plates from hammered ingots the results are the same as for 1in. plates, while from cogged ingots the strength is about equal, and the ductility in favour of, soaking. In the ¼in. plates the results are very similar to those already stated for the other thicknesses, the advantage being first to one side then to the other. Thus the author concludes that the two modes of treatment give practically the same results, the balance of advantages as shown in the tests being slightly in favour of the soaked ingot. Second, comparing the effects of "cogging" or "hammering" ingots, there is practically no difference in the results; in some cases they are in favour of cogging, in others of hammering, the balance, however, slightly inclining to the latter. Third, comparing the results of "cross-rolling" with those of plates which were rolled only in the direction of the length of the ingot, although there is a clear balance in favour of cross rolling, yet the difference is not so great as one would perhaps have anticipated. The tests, taken lengthwise of the plates, are about the same in both cases, but in those taken crosswise, although strength is practically equal in both cases, yet the ductility is decidedly in favour of the cross-rolled plates. Fourth, comparing the results due to different amounts of "work." Strong opinions have from time to time been expressed before this and other institutions as to the very great value to be attached to "work" done on the steel rolled into plates. Mr. Riley never cordially indorsed those opinions, and his experimental results show that the tensile strength in the ¼in. plates is very much higher than in the case of the plates which have undergone little work; but—what one would not have anticipated—the extension is much higher in the latter case, while the contraction of area is not much less in the latter than in the former. The teaching of all this seems to be that if a strong steel is wanted without great ductility, abundance of work must be done upon it; but if a plate of medium strength and of high ductility is desired, an excessive amount of work should not be done upon it; and if increased ductility is wanted, it should be annealed carefully after rolling.

In connection with the "bend tests," a noteworthy point is the corroboration which they give to the conclusions to be drawn from the tensile test results. They also show in a remarkable way the superiority in strength of pieces with planed as compared with sheared edges, and hence the necessity for keeping shear blades, punches and dies in the best possible order.

The paper concluded with some remarks on annealing in the course of manufacture which was not considered necessary.

The first paper read on Friday afternoon was entitled "Notes on the Construction of Blast Furnaces in the Cleveland District in 1887," by Sir Bernhard Samuelson, F.R.S. This paper referred to that read by the author in 1871, before the Institution of Civil Engineers, giving the cost of three sets of blast furnaces, and the whole of the engines and other varied plant connected with them, and then, by comparison, gave the cost of three furnaces and plants of similar sizes built at the present time. The paper is accompanied by detailed and summarised statements of cost, and as the author comments upon the numerous improvements and on many experiments that have been made in the sixteen years that have passed, an abstract of the paper could not usefully be given. A mere statement of the fact that a set of three furnaces can be built and equipped more economically in 1887 than in 1871 is of little use, and we must refer those closely interested to the paper.

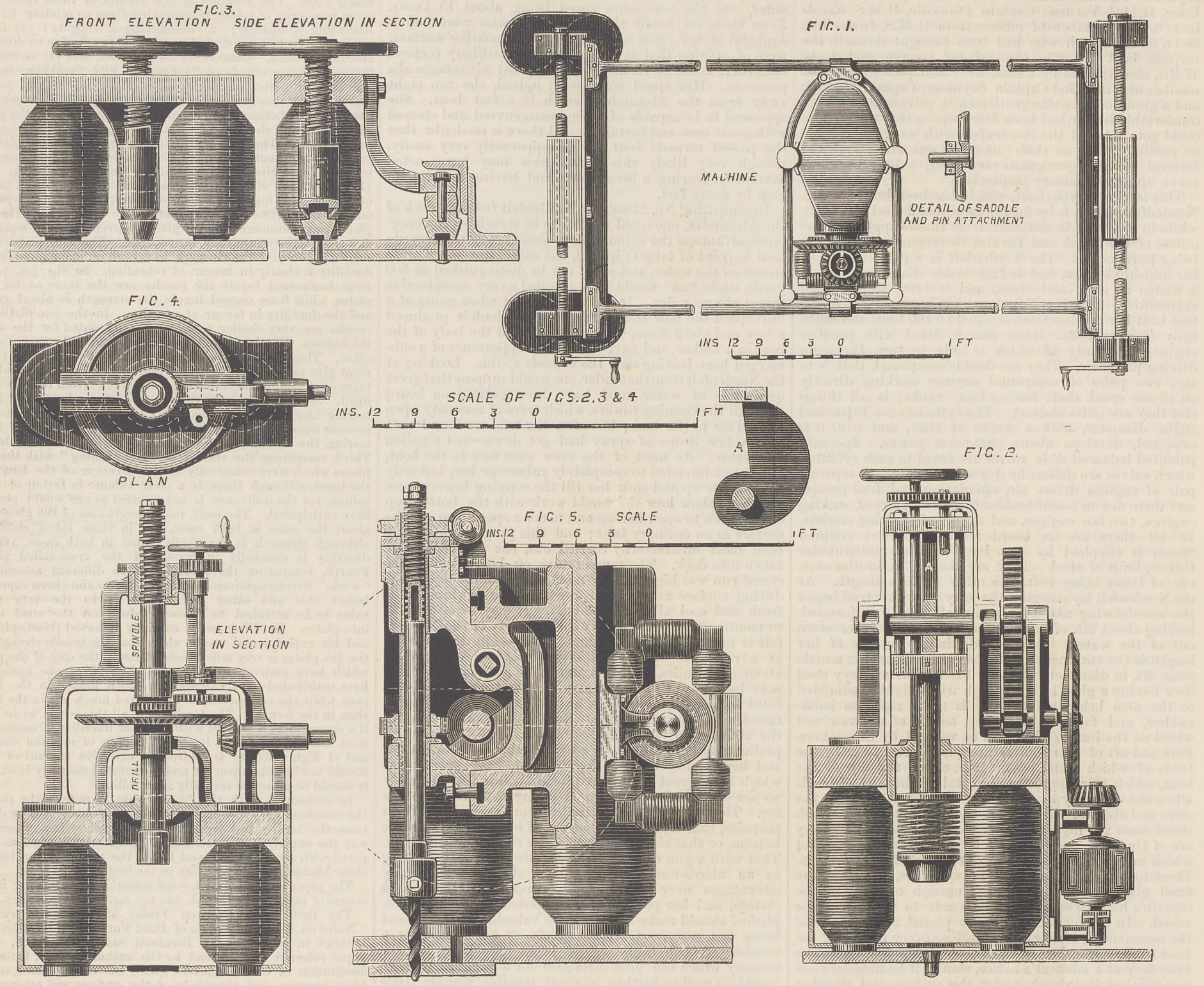
A paper was also read "On the South Chicago Works of the North Chicago Rolling Mill Company," by Mr. E. C. Potter, the general superintendent. These works cover over a hundred acres, and employ about 2000. The company has excellent water facilities for the transportation of ore, and very extensive railway communication, no less than six railways in direct connection with its own yard, and one of those railways having direct connection with each one of the thirty railways entering Chicago. The total cost of the work was £550,000, and the quantity of raw material annually consumed as follows:—Iron ore 400,000 tons, coke 250,000 tons, coal 150,000 tons, and limestone 80,000 tons. Of the total cost £180,000 was expended on the blast furnace department, £150,000 on the Bessemer and rail-mill departments, £14,000 on the slip, and £10,000 on locomotives. The paper describes the plant, and some experiences with it. It was laid down when high prices ruled, and could be now built for 20 per cent. less.

A paper on "The Production of Silica from Cast Iron," by Mr. Thos. Turner, F.C.S., was taken as read.

NAVAL ENGINEER APPOINTMENTS.—John Swanson, staff engineer to the Devastation.

UNIVERSITY COLLEGE ENGINEERING SOCIETY.—The ninth evening meeting of the University College, London, Engineering Society, was held on Friday, May 20th, at 7.30 p.m., Professor Carey Foster, F.R.S., being in the chair. A paper was read by Mr. A. Forbes, Stud. Inst. C.E., on "Fuel." The author began by pointing out the extreme necessity of knowing the properties of different fuels in order that they may be used so as to attain the highest efficiency. He then showed by a table the distribution of British coal in 1882, the greater part of which is used for iron and steel manufacture, namely, 30 per cent. Next he pointed out the chief characteristics of different fuels, including anthracite, bituminous coals, lignite, peat, turf, &c., and showed by a diagram the relative percentage of the different constituents of each fuel. In considering the calorific power he described in detail the calorimeters of Ure, Lewis Thompson, Faver, and Silbermann. He then drew conclusions as to the relative advantages and disadvantages of the different instruments, and described the way in which corrections are made. He then touched briefly on the practical use of fuel and considered the question of furnace draught and combustion efficiency. In speaking of dust fuel, the author concluded with a description of Mr. Crampton's arrangement for burning coal dust. A discussion followed, in which several members of the Society took part.

ROWAN'S ELECTRO-MAGNETIC DRILLING AND RIVETTING MACHINES.



ELECTRO-MAGNETIC TOOLS FOR SHIP-BUILDING.

The superior quality of the work performed by the ordinary hydraulic rivetting machine, over that obtained by hand labour, has prompted many inventive minds to seek for some means whereby the advantages already experienced in the rivetting of frames, beams, &c., may be extended to the bottom and side plating of ships. Machine rivetting had at first to encounter that suspicion and opposition which ordinarily awaits the first application of machinery to any handicraft, and it need scarcely be said that rivetters were even more opposed to machine rivetting than their employers. This opposition has now entirely disappeared, although it is well understood by all concerned that the machine takes the place of many workmen, and is, so far as its application goes, a formidable check against trade strikes. That application is, however, as already remarked, limited to certain portions of the vessel, leaving the entire plating of decks, sides, and bottom, to hand labour.

Two modes of machine rivetting have been hitherto adopted in the construction of ships, viz., the percussive and the compressive. The former is impelled by steam, and the latter by hydraulic power. The steam rivetter strikes the rivet with a hammer, having a rapid reciprocating motion, while the ordinary hydraulic rivetter used in shipbuilding simply squeezes the hot rivet between its powerful jaws. For boiler work, a fixed block is placed inside the cylindrical boiler, and this bearing against the head of the rivet, resists the thrust of the hydraulic punch when the latter presses against the rivet point. If it were practicable to hang a ship in slings and rotate it around a massive block of iron, in the same way as the suspended shell of a boiler, then the rivetting of her bottom and side plating, either by steam or hydraulic power, would be easily accomplished. Up to quite recently, however, no means have been devised for getting over the difficulty presented by the want of such a "holder-up" on the inside of a ship. The use of the ordinary hydraulic rivetter with jaws wide enough to embrace the breadth of a strake of plating has been suggested; but still we have to face the difficulty of moving such a heavy apparatus about from one part of the ship to another, and that difficulty has not been economically surmounted. The ordinary hydraulic rivetter used for rivetting frame, beams, &c., has been tried for the double angle iron keelsons in the flat of the bottom; but the labour of moving even so comparatively light a machine as that has rendered the work more costly than if performed by hand. Keels are commonly rivetted with this machine running upon a line of rails on the top of the keel blocks, but the expense incurred in lifting it for rivetting stems and stern-posts have so far precluded its general use for those parts of the vessel. This limitation of the application of the hydraulic rivetting machine is much to be regretted, for the work it performs is much superior to that ordinarily produced by hand. The hydraulic rivetter effectually closes the work as it proceeds, and consequently the frictional resistance of the joints is greater than would be found in most hand-rivetted work. But not only is the work better, but it is also produced at less cost whenever the conditions of rivetting are such that the machine may readily be applied to the parts which are to be united by rivets.

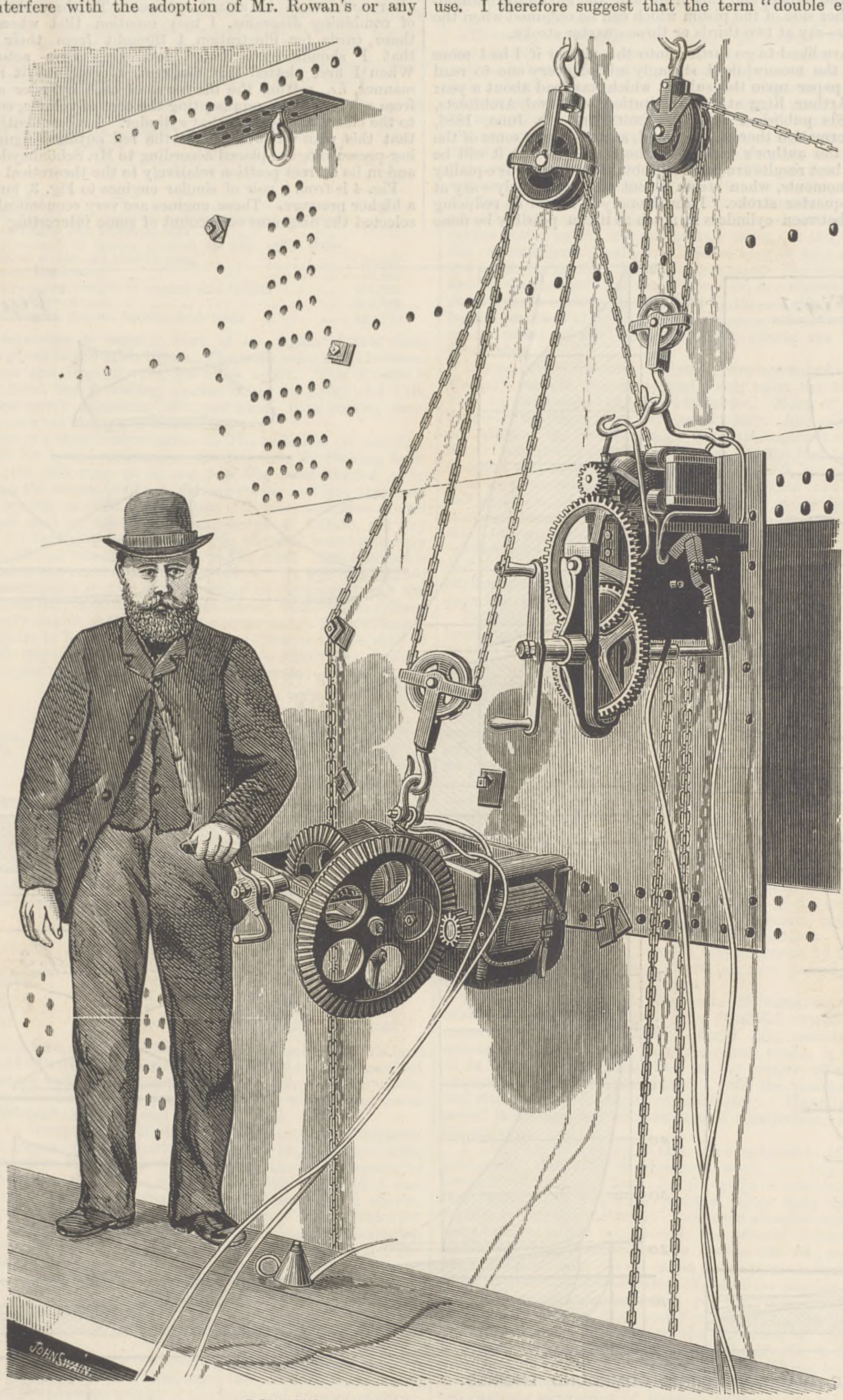
Among the many attempts which have been made to economically apply machinery for the rivetting of the side and bottom plating of ships, that patented by Mr. F. G. Rowan, of Glasgow, seems most likely to ultimately accomplish the object in view. Indeed, as a matter of fact, Mr. Rowan's machines have for some time past been in operation on the premises of Messrs. Macmillan, the well-known shipbuilders at Dumbarton, who, it will be remembered, were the first to practically deal with machine rivetting as applied to ship's plating Mr. Rowan has not confined his efforts to overcoming the obstacle presented in the matter of machine rivetting, but, on the contrary, he has attacked the problems of drilling, countersinking, tapping, chipping, and caulking. His machines are intended to drill and countersink the lap and butt joints of ship's plates as they hang in place against the frames, also to rivet the plates, smooth the rivet surfaces on the outside, and finally chip and caulk the plate edges and butts. All this he has accomplished; but whether the results will ever commercially compete with hand work is a question which remains to be determined. At present the workmen do not seem to be sufficiently practised in the use of the machines to allow the latter a fair chance of developing their full capabilities. Moreover it is quite possible that the machines themselves are not yet perfected to the extent admitted by the principles upon which they are devised.

Mr. Rowan's machines are all impelled by an electro-magnetic motor, the currents being supplied through insulated wires from a steam engine in a shed not far from the ship. The rivetting machine clings to the plating of the ship by virtue of its condition as a powerful electro-magnet, and the "holder-up" on the inside performs its functions by the same means. The driller, chipper, and caulker are similarly capable of being firmly attached to the iron or steel of the ship upon which they are intended to work, and an electric current supplies that force for drilling, rivetting, chipping, and caulking at the ship which was originally developed at the steam engine in the adjacent shed. The machines are suspended from a traveller which passes around the outside of the ship, and under the flat of the bottom special means are provided for supporting their weight by framing and guide bars, which are either bolted to the ship or held in place by electro magnets.

Fig. 1 shows the arrangement of framing for carrying and guiding tools, also an elevation of frame carrying a drilling or other machine, and traversing vertically by means of the screwed guides at each side, the machine moving laterally on the horizontal bars or guides of the frame on which it is carried by a saddle or other arrangement. The frame is attached to the work either by electro-magnets, as shown on the left of the illustration, or by bolts, as shown on the right. This arrangement permits of a considerable area of work being embraced without altering the position of the framing, and may be used either for carrying machines or as guide bars for carrying and shifting the positions of machines in such places as under the bottom of a ship, where lifting tackle cannot be conveniently applied. Fig. 2 shows an elevation, partly in section, of an electro-magnetic rivetter (the motor being omitted) having holding-on magnets and a helical cam. The latter lifts the hammer against a spiral spring, which, when relieved by the cam, operates to produce the blow of the hammer. The spiral spring is compressed between the hammer-head and a disc or plate working in a circular guide-box, its position, and consequently the amount of compression given to the spring, being regulated by two screw spindles working through the top of the guide-box, and moved by gearing. Fig. 3 shows in front elevation, and side elevation in section, one form of an electro-magnetic holder-up for rivetting. It has a curved arm with a supplementary bolster for application to rivets under reverse bars of ships' frames or in confined spaces. The pressure on the rivet head under the main bolster is applied by means of a strong screw worked by a hand wheel, after the holding-on magnets have taken their grip of the plating and a steel or other spring at the back of each bolster permits of the flattening of the rivet head during rivetting being compensated for. Fig. 4 shows one form of electro-magnetic drilling machines with a single drill spindle, the motor being omitted. Feed-gearing is shown, which may be worked by hand or by means of a spur-gearing. Fig. 5 shows another arrangement of drilling machine for either a single-drill spindle capable of being traversed horizontally along the frame to which the motor is attached, or it represents a cross-section of a multiple drilling machine. Machines for tapping and for chipping and caulking have been devised by Mr. Rowan on the same general principles.

Our illustration shows two of the drilling machines at work on the side of a ship, the plating having been previously attached to the framing by means of a few punched holes. The positions of the rivet holes in the laps and butts are set off as required, and by means of the machines the holes are drilled and countersunk with about ten times the rapidity of hand work.

The foregoing will show the principal details of Mr. Rowan's invention, the primary feature of which is clearly the application of electro-magnets for attaching individual machines to work, or work to machines, and for attaching the framing of traversing machines to the hull of a ship. Electrical working has undoubtedly great and special advantages in the easy and economical distribution of power, in the facility of the control of the system and of individual machines, and in the speed of working which is attainable. It seems very probable, therefore, that a field will be occupied in the future by such machinery and there appears to be no reason why ship and boiler construction should not be benefitted by its application. So far as these particular machines have been tried, they have shown themselves capable of doing the work for which they were intended. The drilling machinery is especially successful, both in regard to speed, simplicity of operation, and the work produced. This alone is a most important advantage in steel ship construction, considering the great depreciation in the ductility of the material, which results from punching plates exceeding half-an-inch in thickness. Of course, there is no reason why plates should not be drilled rather than punched before being brought to the ship, except that of extra cost, and it is to be feared that a consideration which has hitherto operated against drilling the great bulk of the plating of a ship will still interfere with the adoption of Mr. Rowan's or any other machinery which cannot approximate in their results more closely to the cost of punching. Mr. Rowan's machinery has, nevertheless, this advantage, that the rivet holes are perfectly true, which cannot be expected from any templated work, however carefully done. But although the speed of his machines is ten times that of hand drilling, the time occupied is still very considerably greater than that of punching, and of course the cost of labour is almost in proportion. We hesitate to speak regarding the ultimate efficiency of the rivetting machines, because the experiments made under our inspection were declared by the inventor to be unsatisfactory in consequence of either the weakness of the hammer-spring coil or a defect in the cam. Certainly the blow delivered was not sufficient for good sound rivetting, nor were the rivets satisfactorily hammered. But that is a detail which admits of improvement, and we see no reason to doubt that, under fair conditions, the rivetter might be found quite equal to its work. The question of rapidly shifting the machinery from hole to hole, and its ready adjustment at each hole, is, in our opinion, the crucial one upon which the commercial success of this invention will be determined. That Mr. Rowan's machines will drill, countersink, rivet, chip, and caulk, there can be no doubt, and it is probably within that gentleman's power to make the rivetting machines capable of doing their work well. But regarding the ultimate commercial aspect of the matter, we prefer to suspend our judgment for the present, while the inventor makes good the defects in the machines that are now apparent and developes the invention in the needed direction. Anyone who sees the drilled holes in the ship upon which the machines are being used will agree with us in thinking it is much to be desired that such excellent work should be economically produced, and that the strength of steel plates which is now lost by punching should be saved by the use of such an appliance.



ROWAN'S MAGNETIC DRILL IN POSITION.

ON COMPOUND ENGINES FOR ATLANTIC STEAMERS.[1]

THE subject of the best type of engines for our Atlantic mail and passenger steamers is one of considerable interest to all marine engineers, and may be profitably discussed from time to time as improvements are made in marine machinery. In the title of this paper I have used the word "compound" in its widest sense, as including all engines expanding their steam in two or more stages. I do not approve of the practice so common of distinguishing between "compound" and "triple or quadruple expansion" engines, as these latter are still more deserving of the term "compound" than the older form; and the use of the term "ordinary compound" is unsatisfactory, as before long triple and quadruple expansion engines will be the "ordinary" compound engines in use. I therefore suggest that the term "double expansion" be substituted for engines in which the steam expanded in two stages, and shall endeavour to adhere to that term throughout this paper. Mr. John, of Barrow, in his paper on "Atlantic Steamers," read at the Liverpool summer meeting of the Institution of Naval Architects last year, pointed out that the large Atlantic lines were very much behind in the type of engines employed, none of the principal companies running to New York having adopted triple expansion engines, although for some years past vessels of considerable size and power had been working successfully with engines of this description. The Propontis, built by Messrs. Elder, under the management of Mr. Kirk, had been successful so far as her engines were concerned; and later, Mr. Kirk at Napier's had been successful with the Aberdeen and some steamers for the Mexican line; and yet when these latter vessels came to Liverpool, and the principal companies sent their engineers to report upon them, they were advised not to adopt the new system.

The principal types of engines hitherto employed in the Atlantic service may be classed under three heads: (1) The ordinary two-cylinder compound engine with intermediate receiver and cranks at right angles. (2) The tandem engine with four or six cylinders—not working, however, on the Woolf principle, as in the earlier engines of this type, but on the receiver principle, the high-pressure cylinders exhausting through pipes to the low-pressure valve casings. (3) The three-cylinder engine, with cranks at equal angles round the shaft, and having one high-pressure cylinder delivering into two low-pressure ones. Of these three types, the first was used in the earlier days of compound engines as applied to Atlantic steamers, and has continued to be employed for engines up to 3000 or 4000 indicated horse-power, but above this the other two types have been most in favour, especially the three-cylinder engine, which we find in the Arizona and Alaska of the Guion Line, the America of the National Line, and the Gallia, Servia, Aurania, Umbria, and Etruria of the Cunard Line. The tandem type has been chiefly confined to the vessels of the White Star Line and the City of Rome.

[1] Paper read by Mr. J. Jennings Campbell before the Liverpool Engineering Society.

The first cause of the large consumption of fuel by these steamers is, in my opinion, the smallness of the engines in proportion to the power developed, in consequence of which the steam is not expanded far enough to produce a very economical result. In some of the early compound marine engines, such as those fitted to the coasting paddle steamers of the Pacific Steam Navigation Company, some twenty years ago, the steam was expanded down to a pressure of about 6 lb. absolute in the low-pressure cylinders; and these vessels used to run with a consumption of $2\frac{1}{4}$ lb. of coal per indicated horse-power per hour, and sometimes less, although the boiler pressure was only 40 lb. In the early ships of the African Mail Company I believe that similar results were obtained, although all these engines worked on the Woolf principle, which is much less efficient than the "receiver" one when both are carried out in the best manner.

The majority of the large Atlantic steamers of the present day burn very little less coal than these did, in spite of the increase of pressure from 40 lb. to 110 lb., and the much higher piston speeds now employed. I believe that the White Star boats have run ever since they were built, some fifteen or sixteen years ago, with a consumption of less than 2 lb. per I.H.P. But these vessels have not the large powers and high speeds of the later built Atlantic liners. In fact it seems that the increase of pressure and piston speed has been used solely to augment the power given out in proportion to the size of the low-pressure cylinders adopted, and not to allow of a greater expansion of the steam and consequent increase of economy. This seems to me to be a mistake, and I believe that in the long run it would prove cheaper to make the engines larger for their power even at a somewhat increased first cost, and to work the steam more expansively. In the large majority of merchant steamers other than mail and fast passenger boats, the usual working power of the engines is considerably below the maximum, and consequently while the mail steamers are continuously burning some 2 lb. to $2\frac{1}{4}$ lb. of coal per I.H.P. per hour, there are many cargo boats running even with double expansion engines at a consumption of about $1\frac{1}{2}$ lb. per I.H.P. per hour at their ordinary speeds. And I believe there are triple expansion engines running with a consumption of little over $1\frac{1}{4}$ lb. In the Atlantic mail service, however, we have a totally different condition of affairs, the ships running continuously at their maximum power, or nearly so, when once they have cleared the docks or harbour whence they start. Their engines might, therefore, advantageously be proportioned for the greatest possible efficiency when giving out their full power. In other vessels it is necessary to allow for working at lower powers for long periods together, and this means more expansion, but in the mail boats no such allowance is necessary. In the early screw steamers of the Pacific Company, viz., the Magellan, &c., indicating some 2000-horse power, and working at 60 lb. boiler pressure, the low-pressure cylinders were 96in. diameter, and the piston speed was not more than 480ft. to 500ft. per minute. If the steam in the Umbria and Etruria were expanded to the same terminal pressure in the low-pressure cylinders as in the Magellan, then allowing for the increased piston speed of some 800ft. per minute, and for the higher mean pressure due to expanding steam at a boiler pressure of 110 lb. down to the same terminal pressure, the low-pressure cylinders of these latter engines would require to be about 129in. diameter instead of 105in. Taking these engines as 14,000 I.H.P.—they have worked over to 15,000—and halving this, as there are two low-pressure cylinders, and taking the piston speeds of these and the Magellan class at 800ft. and 480ft. respectively, we get for the same power:

$$800 : 480 :: 96^2 : 74\tfrac{1}{2}^2 \text{ nearly,}$$

$$\text{and as } 2000 : 7000 :: 74\tfrac{1}{2}^2 : 139^2$$

Then, taking the expansions in proportion to the initial pressures, or as 60 + 15 to 110 + 15, *i.e.* 75 : 125, and calling that in the Magellan Class 9, and in the Umbria Class 15, the mean pressures all referred to low-pressure cylinders will be approximately in the proportion of

$$75 \times \frac{1 + \text{hyp. log. } 9}{9} : 125 \times \frac{1 + \text{hyp. log. } 15}{15} \text{ or } 106 : 123.$$

$$\therefore\ 123 : 106 :: 139^2 : 129^2 \text{ nearly.}$$

Thus our fast Atlantic steamers have smaller cylinders in proportion to their power than the average cargo boat, even allowing for higher piston speed and pressure.

The second cause of large fuel consumption is one common to most of the compound engines made for marine purposes, whether double or triple expansion, and that is, the drop of pressure between the different stages of expansion. I do not wish to overrate the loss of power due to this cause or to lose sight of the probability that some of it is probably regained by the superheating action which is said to take place when the steam expands into the receiver without doing external work. But I think that, considering how low the total efficiency of our marine machinery—including boiler, engine, and propeller—is, we ought to try and gain every advantage we can, taking care that in avoiding loss in one direction we do not create one elsewhere. It is only by combining together the diagrams from the different cylinders in a correct manner that we can arrive at a just estimate of the losses in the cylinders of any kind of compound engine, and there are some losses which we cannot ascertain with any degree of accuracy from diagrams at all. The losses, however, due to the disproportion between the ratio of cylinder and the cut-off in the later one are discoverable from properly constructed combined diagrams; and a careful study of these will show that a considerable loss of area—viz., of work done for steam used—is caused by the drop between the terminal pressure at the end of the first cylinder's stroke and the back pressure at the beginning of the return stroke This loss may also be approximately calculated from theoretical diagrams or from the ordinary calculations for compound engines, such as those found in D. K. Clark's tables or in Holmes' new text book of the steam engine. But the losses will not then seem so great in proportion to the work done as they really are, as these calculations and theoretical diagrams do not take account of the other losses which we find shown on actual diagrams, such as those due to wire-drawing, early release and compression, and drop or difference between the back pressure in one cylinder and the admission pressures in the next. This latter "drop" must not be confounded with that previously mentioned. The whole loss of area from "drop" is caused by the difference between the terminal pressure in the first cylinder and the cut-off pressure in the next. This is made up of the two "drops" or differences of pressure already referred to, which are due to quite different causes. The difference between the terminal and minimum back pressure in the first cylinder is due to the volume of steam admitted to the second cylinder being greater than the volume discharged from the first at terminal pressure. The difference between the back pressure in the first cylinder and the admission pressures in the second is due partly to the friction of the passages from first cylinder to receiver and from receiver to second cylinder, and partly to initial condensation and wire-drawing in the latter. The first can be entirely eliminated, but the second can only be reduced to a minimum.

Take an example:—Suppose we have an ordinary double expansion engine with cylinders having a ratio of 1 : 4, and cutting off at half stroke in both cylinders, the initial pressure being 80 lb. absolute. Then disregarding clearance and compression, and assuming a receiver so large as to give a practically constant pressure therein, we shall have a terminal pressure of 40 lb. in the high-pressure cylinder; and as the volume of steam admitted into the low-pressure cylinder is twice the capacity of the high-pressure—or twice the volume discharged at terminal pressure from the high-pressure—the pressure in the receiver—which we may take as being the same as back-pressure in high-pressure cylinder and admission pressure in low-pressure cylinder—will be 20 lb.; therefore the mean pressure in H.P. will be:—

$$= \frac{80}{2} \times 1 + \text{hyp. log. } 2 = 67{\cdot}7 \text{ lb.}$$

Deducting back-pressure	20
Effective mean pressure	= 47·7 lb.

This, divided by 4 (cylinder ratio) = 11·925 as the equivalent pressure per square inch of low-pressure piston. In the low-pressure cylinder we have:—

$$\text{Mean pressure} = \frac{20}{2} \times 1 + \text{hyp. log. } 2 = 16{\cdot}9$$

Back pressure, say		3·0
Effective mean pressure	=	13·9 lb.
Add H.P. mean pressure ÷ 4	=	11·925 lb.
Total effective mean pressure	=	25·825 lb.

for the whole engine, all referred to low-pressure cylinder. If we had no drop, the mean pressure should have been the same as if we had expanded 80 lb. steam eight times in one cylinder the same capacity as our low-pressure cylinder, viz.:

$$= \frac{80}{8} \times 1 + \text{hyp. log. } 8 = 30{\cdot}8 \text{ lb.}$$

Less back pressure as before =	3·0 lb.
we have effective mean pressure =	27·8 lb.

showing a loss of nearly 2 lb., or 7·2 per cent.

If we assume that the other and unavoidable losses due to wire-drawing, release, compression, &c., amount to 20 per cent., or say 5·6 lb. in each case, we have 20·225 and 22·2 as the effective mean pressures instead of 25·825 and 27·8, or a loss due to drop = 9·0 per cent. instead of 7·2. In addition to this the compression in the high-pressure cylinder will practically reduce the volume of steam discharged from the high-pressure cylinder, while the imperfect compression in the low-pressure cylinder leaving a portion of the clearance to be filled from the receiver, slightly increases the volume of steam admitted to the low-pressure cylinder; so that the volume actually admitted to it will be more than twice the volume discharged from the high-pressure cylinder at terminal pressure, and consequently the receiver pressure will be less than 20 lb., and the drop therefore greater. If both cylinders had clearances equal to 10 per cent. of their working capacities, and if the high-pressure cylinder compressed at seven-tenths of the stroke, and the low-pressure just enough to half-fill its clearance—or fill it at half the initial pressure—then the volume of steam discharged at 40 lb. from the high-pressure cylinder will be 85 per cent. of its working capacity, while the volume admitted to the low-pressure will equal $2\frac{2}{10}$ the volume of high-pressure cylinder, so that the receiver pressure will be $= 40 \times \frac{8{\cdot}5}{22} = 15{\cdot}45$ lb., instead of 20 lb., giving a greater drop, and consequently a greater loss of efficiency.

There are no two opinions as to the loss of area in the combined diagrams thus caused by drop, but many engineers endeavour to make out that most of this loss is recovered in another way, owing to the superheating action caused by the steam expanding into the receiver without doing external work, *i.e.*, without doing other work than that necessary for the separation of its particles. Others, again, defend the acceptance of this loss on the ground that it enables them with the ordinary types of engines to equalise the initial strains on the working parts, and obtain tolerably equal powers in the cylinders without a large high-pressure cylinder and a very early cut-off therein.

In the case of two-cylinder double expansion engines and the ordinary type of three-cylinder triple-expansion engines, the latter arguments have a certain degree of force if not carried too far, but much less than is generally supposed; and, as to the first argument, I believe there is very little in it, and that the superheating is far from sufficient to make up for the loss of area on the diagrams. The most successful two-cylinder engines I have known had comparatively small cylinder ratios, and correspondingly greater expansion in the high-pressure cylinder.

In the case of tandem engines and three-cylinder double expansion engines the conditions are different, and much better driving pressures can be obtained with smaller cylinder ratios and earlier cuts-off in both cylinders. In the latter type of engines, when worked with large cylinder ratios, the difficulty has been to keep down the power in the high-pressure cylinder relatively to the two low-pressure without either an inconveniently early cut-off in the low-pressure or a very late admission to the high-pressure. And in speaking of this late cut-off in a cylinder, there is a point which does not receive sufficient attention from marine engineers, and that is, the effect of the inertia of the reciprocating parts. In fast-running engines with a late cut-off, the pressure acting upon the crank pin in the direction of the piston's motion towards the end of the stroke, due to the combined action of steam and the momentum of the moving parts, is surprising to those who have not worked it out, and is far greater than the maximum steam pressure during the stroke, and this in spite of the moderate cushioning on the other side of the piston which can be obtained when the cut-off is late—say at two-thirds or three-quarter stroke.

I should have liked to go further into this matter if I had more time, but in the meanwhile I strongly advise every one to read carefully the paper upon this subject which was read about a year ago by Mr. Arthur Rigg at the Institution of Naval Architects, and afterwards published in THE ENGINEER, 4th June, 1886. From the information therein contained, and also from some of the diagrams in the author's treatise on the steam engine, it will be seen that the best results are generally obtained, as regards equality of twisting moments, when steam is cut off pretty early—say at one-third or quarter stroke. I am strongly in favour of reducing the "drop" between cylinders as much as it can possibly be done without upsetting the working pressures in other respects. This is such a large subject that it would almost require a paper to itself, and I must pass on to other matters.

The third cause of inefficiency in all classes of compound engines is a disregard of the point I have just alluded to, viz., the wonderful effects of inertia; and although there are a few engines running in which the steam distribution is good in relation to this matter, I fear it is not the case in the large Atlantic steamers, especially in the high-pressure cylinders, where the admission generally extends far beyond the half-stroke, and often reaches two-thirds or seven-tenths, while in the low-pressure cylinders the diagram generally shows a steady fall all the way. I have here diagrams combined from the indicator cards of various types of compound engines. These are all combined on the system recommended by Mr. Schönheyder at the discussion on the late Mr. Wyllie's paper, read at the Middlesbrough meeting of the Institution of Mechanical Engineers, and previously more clearly described by him in a letter to *Engineering* on October 27th, 1871.

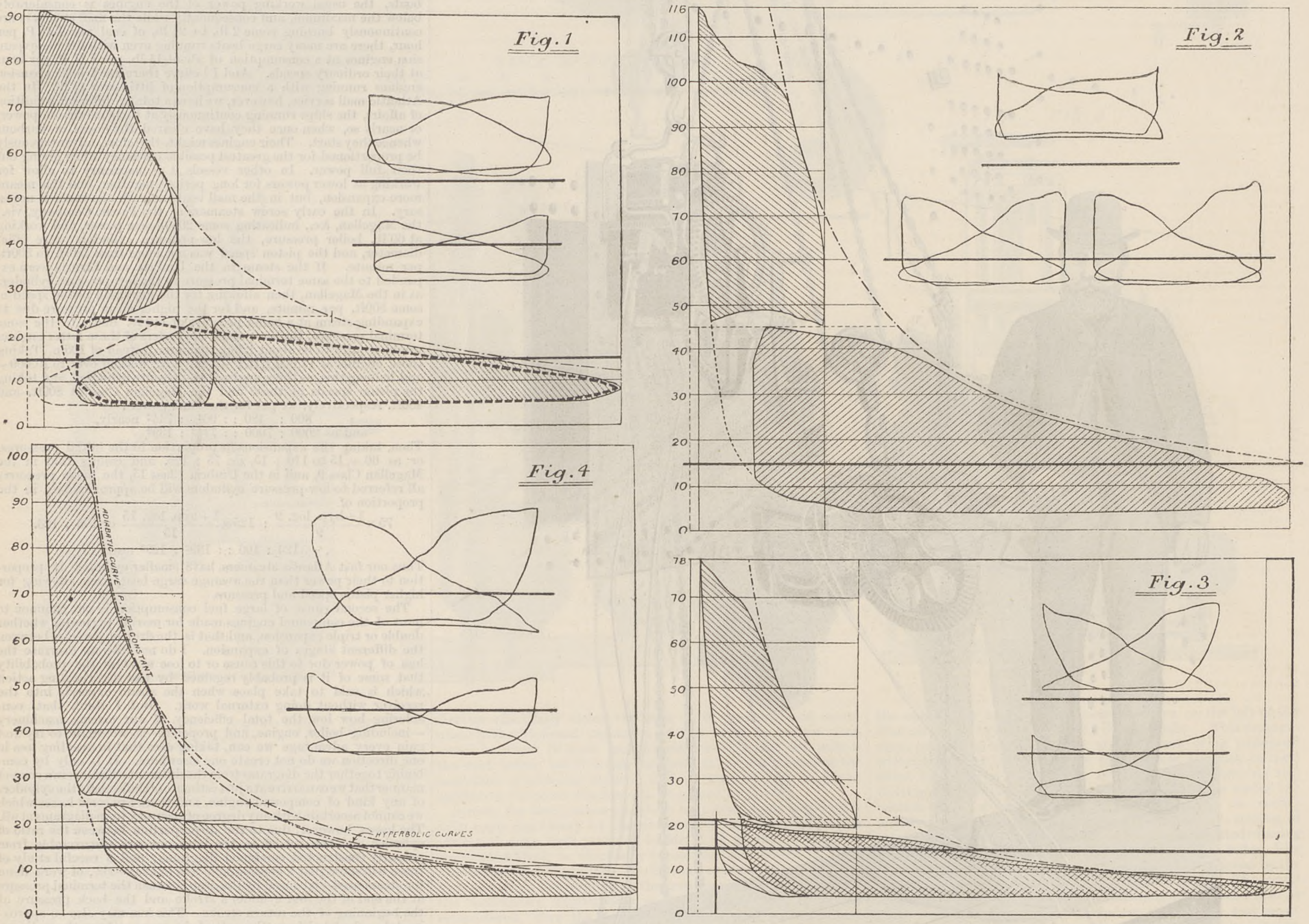
Fig. 1 is from a set of tandem engines in the Atlantic mail service; and here you will see that there is a large drop due to the late cut-off in the low-pressure cylinder and the tolerably large cylinder ratio. There is also a great difference between the back pressure in high-pressure and admission pressures in low-pressure cylinder, as shown by the small dotted figure, which shows the low-pressure diagram the same length as the high-pressure, and in the proper place relatively to it for showing this point. The full lined figure shows the low-pressure diagram divided into two, and placed in the correct position for comparing its expansion curve with the theoretical one carried on from the high-pressure diagram. The dotted line simply shows the low-pressure diagram extended to a length proportionate to the capacities of cylinders. The theoretical curves are hyperbolic.

Fig. 2 is a combined diagram of a set of three-cylinder engines belonging to one of our large Atlantic Liners, but I am not at liberty to give either the name of the ship or the company under whose flag she sails. In this diagram you will notice that the low-pressure diagram is about twice the area of the high-pressure one on account of there being two low-pressure cylinders, and, in fact, at the power developed when these cards were taken the power in the three cylinders is almost identical. This figure illustrates the remarks I made about "drop," for although the cylinder ratio is only a little over 4 : 1 and the low-pressure valves cut off at about 35 per cent. of the stroke, there is more drop than you would expect, owing partly to the compression in the high-pressure cylinder and partly to the low-pressure clearance not being completely filled with steam at the initial pressure. These engines give a very high speed with a consumption of a little over 2 lb. per indicated horse-power per hour.

Fig. 3 is from a pair of two-cylinder compounds built many years ago on the East Coast and said to have worked on the trial trip with a consumption of only 1·4 lb. per indicated horse-power per hour, but as the trial only lasted two hours this record is not very valuable. But even if they did not work quite so well as this there is no doubt that they were very economical afterwards when in actual service. To show the advisability of combining diagrams, I may mention that when I selected these cards for illustration I thought from their appearance that I should have found less drop than actually exists. When I first plotted this diagram, I combined it in the usual manner, *i.e.*, setting the diagrams of each cylinder at a distance from a vertical line, representing the zero of volume, corresponding to the clearance space in that cylinder. I subsequently discovered that this plan was wrong, and the red outlined figure shows the low-pressure figure placed according to Mr. Schönheyder's method, and in its correct position relatively to the theoretical curve.

Fig. 4 is from a pair of similar engines to Fig. 3, but working at a higher pressure. These engines are very economical, but I have selected the diagrams on account of some interesting experiments that have been made on the condensation in the cylinders. The cards shown represent a consumption of about 1·66 lb. per indicated horse-power per hour with South Wales coal, the engines indicating about 1350-horse power. There are no jackets to the cylinders; and I have made the theoretical curves adiabatic instead of hyperbolic, as I found that the latter showed a greater quantity of steam just after cut-off than just before release, which is not likely to be correct. The amount of water condensed in the high-pressure valve-casing, *i.e.*, before the steam enters the engines at all, is 5 gallons per hour, and the quantity obtained from the low-pressure valve-casing forming part of the receiver is equal to 100·9 gallons per hour[1] = 10·8 tons in 24 hours. When the water is not drawn off from the receiver a considerable amount is got from the low-pressure cylinder; but when this is done none is obtained. The water runs into a small tank fixed under the cylinders and fitted with a gauge glass, and is drawn off through a cock to the hot well, where it raises the temperature of the feed-water some 4 deg. or 5 deg. When working the cork is adjusted to keep the water-level pretty constant.

At first sight, 11 tons a day seems a lot of water to get; but when the power developed is taken into account, together with the fact that this is the only water obtained from both cylinders, and these unjacketted, the quantity is far less than one might expect. Measured from the H.P. cards, which probably do not show all the steam that enters the cylinder, the water used seems to be about 201·11 tons per twenty-four hours, so that the condensation only amounts to 5·47 per cent. It is not easy to determine whether all this condensation takes place in the H.P. cylinder or part of it in the receiver, but I believe the former to be the case, and that it consists partly of the initial condensation and partly of that due to the work done. When these engines are exerting a much smaller power and the ship is light, very little water is found, but as soon as the vessel is loaded and the valves opened up, water forms at once. This may be partly accounted for by more re-evaporation taking place with the earlier cut off. It will be noticed that these engines have a good deal of compression, and I believe that they are the same engines I have heard of as having



COMBINED DIAGRAMS FROM COMPOUND ENGINES.

[1] It is given on the cards as 3 gallons in 1 min. 47 sec., or 2422 gallons per 24 hours.

run twice out to India and back without requiring to let up the main bearing brasses. I hope some time, if I can obtain the weights of the reciprocating parts, to work out a diagram of torsional strains, which I expect to find very uniform when the combined effect of steam and inertia are taken into account.

(*To be continued.*)

PERFORMANCE OF A WOOTTEN ENGINE.

THE following particulars as to the actual performance of a Wootten engine in regular working are perhaps the fullest that have ever been published. The figures have been kindly supplied to us by Mr. John W. Cloud, the Superintendent of Motive Power of the New York, Lake Erie, and Western, and show the work done by one of the passenger Mogul engines with Wootten fire-box, recently built for that road by the Baldwin Locomotive Works. These engines are unusually heavy and powerful engines for passenger traffic. Their principal dimensions are as follows:—

Cylinders, diameter and stroke	20in by 24in
Driving wheels, diameter	68in.
Tractive power per 1lb. average pressure in cylinders	141·2 lb.
Weight in working order—	
Drivers	95,300
Truck	18,700
Total	114,000
Average weight of tender at commencement of trip with full tank and 16,400 lb. coal	82,717
Average weight of tender at end of trip with 1200 gallons of water aud 5550 lb. coal	56,667
Mean weight of tender	69,292
Average running weight of engine and tender	183,292
Average weight of cars	242,888
Average weight, engine, tender, and train	426,180

The performance in regular work of an engine of this class, No. 137, is given in the table below. The trips were made between Susquehanna and Hornellsville, 139 miles apart. This division is practically level, the prevailing grades being 5ft., 8ft., and 11ft. per mile, and never exceeding 14ft. per mile. The curves, however, are somewhat sharp and numerous.

The engine ran from Susquehanna to Hornellsville on one day, taking train No. 1, and returned on the following day taking train No. 8. In the following table, one trip has been omitted, as on that occasion the engine broke a driving spring and left the train at Elmira, coming on with a later train. The consumption of coal includes that used in lighting up, an average of 2200 lb. per day being used for this purpose. On one trip, the coal board gave way and 2000 lb. of coal was lost and spilt on the road. This amount is not included in the consumption given below. It will be observed that the consumption of fuel differs greatly on different days. On December 16th only 8000 lb. of coal was burnt, while on the following day nearly double this quantity was consumed. This difference does not appear to be due to any decided difference in the skill of the firemen employed. The following table shows the average performance per trip of the three different firemen:—

Fireman.	Speed whilst in motion. Miles.	Water used. Gals.	Coal used. Lb.	Lb. water per lb. coal. Lb.	Weight of train. Lb.
Crawford	40·4	6289	10,416	5·03	418,210
Foley	40·8	6307	11,125	4·72	421,490
Elston	43·6	6160	11,250	4·56	423,100

It will thus be seen that while fireman Crawford evaporated most water per lb. of coal, his average train was lighter and the speed considerably less than with Foley and Elston. The latter shows the lowest evaporation, but had, on the average, a slightly heavier train running at a greater speed.

The engineers were not always mated with the same fireman. The average results per trip are as follows:—

Engineer.	Average speed whilst in motion. Miles.	Water used. Gals.	Coal used. Lb.	Weight of engine, tender, and train. Lb.
Delancy	42·6	6370	9500	426,700
Pettit	41·3	6002	10,833	414,833
McDonald	40·4	6289	10,416	418,250

Mr. Delancy thus appears to have had the advantage of the best firing—he had two different firemen—while Pettit used the smallest amount of water and the largest quantity of coal. On the whole, these figures show that the performance of the engine was much alike with different engineers and firemen.

It should be borne in mind that in a Wootten engine the engineer and fireman are so widely separated that the engineer has little power to control or instruct his fireman as to the consumption of fuel, and therefore any blame or credit on this score must rest almost entirely upon the fireman. The engineer has, of course, almost complete control over the consumption of water, but even here a good fireman can render considerable assistance by avoiding waste of steam from the safety valves blowing off at stations. The average train was composed as follows:—

Postal car	·93	Hotel	·13
Baggage car	1·00	Official	·07
Pullman parlour	1·00		
Smoker	1·00	Total number of cars	5·80
Coach	1·67		

The following table shows the speed, delays at stations and on the road, the total number of stoppages, the consumption of water and coal, and the average weight of the train and number of cars:

NEW YORK, LAKE ERIE AND WESTERN RAILROAD.

Performance of Wootten Mogul Engine No. 137, *running express passenger trains between Susquehanna and Hornellsville.*

Date. 1886.	Time including stops. H. M	Time in motion. H. M	Average speed. Including stops. M'ls.	Average speed. Excluding stops. M'ls	Number of stops.	Water used. Gals.	Coal used. lb.	lb. water per lb. coal. lb.	Lb. coal per mile. lb.	Average steam pressure. lb.	Weight engine, tender and train. lb.	Number of cars.
Dec. 2	3 59	3 32	—	—	11	7215	12,000	—	—	138	441,200	6
Dec. 4	3 49	3 22	—	—	11	6565	13,000	—	—	140	447,300	6
Dec. 5	4 46	4 21	—	—	13	6500	10,000	—	—	128	433,340	6
Dec. 6	3 44	3 22	—	—	11	6792	10,800	—	—	140	431,400	6
Dec. 7	3 43	3 21	—	—	13	5395	10,200	—	—	138	378,650	6
Dec. 8	3 38	3 15	—	—	11	6119	10,000	—	—	134	434,400	6
Dec. 9	3 38	3 10	—	—	13	5493	8,500	—	—	135	378,240	5
Dec. 10	4 11	3 9	—	—	11	6565	11,500	—	—	138	434,400	6
Dec. 11	3 38	3 14	—	—	13	5720	8,500	—	—	135	381,650	5
Dec. 13	3 49	3 23	—	—	11	5818	11,500	—	—	135	434,400	6
Dec. 14	3 38	3 14	—	—	13	6435	10,000	—	—	135	505,250	7
Dec. 15	3 59	3 21	—	—	11	7215	13,000	—	—	135	434,400	6
Dec. 16	3 38	3 10	—	—	13	5850	8,000	—	—	130	381,650	5
Dec. 17	3 36	3 8	38·6	44·1	11	6760	15,000	—	—	138	494,750	7
Dec. 18	3 43	3 14	—	—	13	5590	10,000	—	—	135	381,650	5
Average.	3 50	3 21	36·26	41·5	12	6268	10,800	4·83	77·7	135·6	426,180	5 8

—*Railroad Gazette.*

As one of the men on board the Humber guardship, H.M.S. Rupert, was on Monday about to throw what is known as a hand charge, a projectile used for throwing into the approaching boat of an enemy, it exploded prematurely, the upper portion of the man's body being terribly shattered, and death instantaneous. The instructor was also very seriously injured; also two others.

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

(*From our own Correspondent.*)

THE holidays have kept the mills and forges shut half this week. Some works restarted on Wednesday night, but many will continue closed the week through. Firms whose machinery is again running have mostly orders in hand that are required for shipment and that will brook little delay. Merchants give makers very short time now in which to execute orders, and the holidays are therefore occasionally inconvenient. The new orders which have arrived this week are not large, but makers here note with satisfaction the better returns of the North of England manufactured iron trade, as evidence that steel is not yet monopolising all the demand.

A few of the bar and hoop makers reported in Birmingham this—Thursday—afternoon the receipt of orders which have been accustomed to go elsewhere, and to this extent they are more active, but any attempt to get better prices is unsuccessful; it is only followed by a loss of the orders. Makers have therefore to be content with former rates. That these are unsatisfactory will be seen when it is mentioned that common bars are over £4 15s.; yet imported Midland pigs are 3s. per ton higher than when £4 15s. ruled for bars a year ago. Northampton pigs, which at the earlier date were about 33s. per ton, are now 36s. per ton. Merchant bar orders are small at £5 to £5 10s. at works, or £5 15s. to £6 5s., according to quality, delivered London. Superior bars are £6, with a quiet demand. Australian orders have come forward rather better by the last one or two mails, but they are still below the expectations of makers. Marked bars at £7 and £7 12s. 6d.—the latter being Earl Dudley's quotation—are very slow. One or two of the marked bar firms, however, are showing commendable enterprise in seeking to stimulate India and other export demands by the presence abroad of direct representatives to inquire into the exact needs of the markets. Such efforts are already telling favourably.

Hoops, strips, channel, and angle iron are only in moderate call. Happily makers do not depend solely upon the home trade, but have a good number of export inquiries. More of these could be booked if the prices were more satisfactory. Australia, Spain, Italy, and other of the Mediterranean markets, together with some of the South American countries and India, are the best buyers of hoops. Coopers' and export hoops are quoted at £5, but merchants state that they can place orders at £4 17s. 6d. Gas tube strip is in fair call at £4 15s. to £5 for narrow sorts, and nail strip of 24in. width is about a similar figure. Hinge strip is quoted £5 15s. with small sale, and makers will do business at £5 12s. 6d. Best North Staffordshire hoops, delivered Liverpool, are quoted £6 2s. 6d., and best waved hoops, £6 7s. 6d. The closing of one large South Staffordshire works is leading to other bar and hoop and strip firms securing more orders.

Rumours are again upon the market of a proposal by certain local ironmasters to start the manufacture in Wales, under a patent, of steel tube strip rolled with a feather edge, which would specially recommend it to the welded tube manufacturers. But the matter is at present in embryo.

Reports are in circulation of the intention of additional black ironmasters to lay down plants for the galvanised corrugated sheet trade. The low prices that can now alone be got for black sheets afford the main reason for these proposals. More profit is undoubtedly to be got upon galvanised sheets. But unless restraint is exercised, the galvanised trade will be as much overdone as the black sheet trade has been, and prices will then quickly fall. Singles are £5 17s. 6d. per ton, and occasionally £5 15s. for hard qualities. Doubles are £6, and lattens £6 15s. to £7. Soft qualities, which are demanded chiefly by the Liverpool galvanisers, are quoted 2s. 6d. to 5s. per ton in excess of hard sorts. Plates keep dull, the result of outside competition and of the growing favour of steel. Tank sorts are £6 5s. to £6 10s. at the works, and occasionally £6 15s. delivered London. Common boiler are £7 to £7 10s., and superior sorts £8 10s. to £9 per ton.

Some expectation was aroused this afternoon by the intelligence from Pekin that the Chinese Court has now definitely determined upon the construction of railways.

The new Canadian and Russian tariffs continue to be much discussed by the ironmasters. The "official explanation" of the reason for the new Dominion Tariff Bill, namely, a desire to encourage British rather than American trade, is regarded here as in some sense a mitigation of the serious offence which the announcement at first occasioned. Still the position for our iron and steel masters continues unsatisfactory. Happily there is some set-off in the anticipated reduction of Antipodean tariff charges in the autumn.

A little more activity is this week noticeable in specifications authorising deliveries of pigs next week, but beyond this trade keeps in a tame condition. Local pigs have maintained their position better than imported qualities, since they did not rise so rapidly in the first instance. Hot blast all-mine pigs are changing hands at 50s. to 52s. 6d., though the general quotation is 52s. 6d. to 55s. per ton. Part mines are 40s. to 42s. 6d., and cinder sorts 29s. per ton easy. West coast hematites remain nominal at 57s. 6d. to 60s., with fair sales; Welsh ditto are 52s. 6d. for forge. Lincolnshire pigs are about 39s. per ton, delivered to consumers' works; Derbyshires, 37s.; and Northamptons, 36s. per ton easy.

A lecture was delivered to the members of the Birmingham Chamber of Commerce on Thursday by Mr. H. S. Hallett, on the development of trade with Burmah and China by means of the construction of a railway connecting those countries. He pointed out that our acquisition of Burmah gave us an opportunity of improving the trade with the Shan States, Western China, and probably a large portion of the Chinese Empire. The Chinese Government was quite willing to meet us in the matter, but he was afraid great pressure would be needed to induce the Indian Government to take advantage of the opportunity. A resolution was passed approving of the proposal, and urging its adoption by the Government.

Arrangements are being made to establish a co-operative nut and bolt works at Darlaston, and prospectuses will shortly be issued setting forth particulars of the scheme, and inviting the purchase of shares by the general public as well as by the nut and bolt makers.

Those Cradley Heath chainmakers who have returned to work will come out on strike again, probably at the beginning of the week, their reason for so doing being that many of the employers still persist in violating the provisions of the Factory Act.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Whitsun week in this district, and especially in the neighbourhood of Manchester, means, as usual, such a complete disorganisation of trade that, so far as business is concerned, there is comparatively very little to report. About Tuesday and Wednesday works and collieries commence closing for the holidays, and ordinary operations are scarcely fully resumed until the following Tuesday and Wednesday, so that there is practically a complete week given up to the holidays, and business operations have to suffer to much the same extent. Under such conditions it is useless attempting any really accurate estimate of the state of trade, but so far as the business doing just prior to the holidays affords an opportunity of judging, a tolerably firm tone is apparently being maintained, both in the common and hematite qualities of pig iron, although there are merchants who are still underselling, and in some instances to what would seem almost a reckless extent. In finished iron, the continued absence of any weight of new work coming forward is visibly weakening the position of makers, and quoted list rates are being broken through to such an extent, where there are actual orders to be got, that they are becoming little more than nominal.

The usual Tuesday's iron market was held at Manchester on Tuesday, but although this was the only 'Change meeting during the week, it was quite of a holiday character, and drew together only a thin attendance, and there was very little attempt at actual business. Prices were scarcely quoted, and consequently for the most part were simply nominal. In common pig iron the slight upward tendency reported last week is scarcely being maintained. Where makers do hold out for an advance upon late rates they are out of the market, and in some instances a disposition is again being shown to entertain offers. In outside brands coming into this market Middlesbrough iron is fully maintaining its price, and Scotch iron has shown some appearance of more firmness, but there are still sellers at under quoted rates.

Hematite makers are mostly holding firmly for some advance upon late rates. They are, however, asking prices which buyers do not show any disposition to pay, and there are sellers in the market prepared to book orders at under makers' current quoted rates.

In manufactured iron there is only a very slow business doing, and although makers do not openly quote under the current list rates, they do not allow orders to pass where concessions are absolutely necessary to secure them.

In the engineering branches of industry, with the holiday stoppages of the works, actual operations are for the present suspended, but there is no real improvement to report on the prospects of trade so far as the general condition of works in this district is concerned. It is only in a few exceptional cases that works are what may be termed well supplied with orders, and where there is new business to be got, it has still to be competed for quite as keenly as ever, with the result that in many cases it barely leaves any margin whatever over the actual cost of production.

The Bolton strike is of course the question which just at present is attracting the most attention. Negotiations were opened last week between the employers and the men with some view to a settlement of the dispute, but they fell through, and for the present the holidays prevent any further steps being taken in the matter. The employers have, however, gone as far as they are prepared to go towards meeting the men, and if negotiations for a settlement are to be again opened up they will have to be invited by the men. A determined feeling seems at present to exist on both sides, and in view of the possibility of a protracted struggle one of the large firms is already making preparations for the complete housing on their own works premises of the new men who may be engaged to take the place of those who have gone out on strike.

Some time back, in my notes, I gave a brief description of the Lucigen light which had been introduced in several works in this district by the Hannay's Patents Company. This light is produced by burning common oil in a special form of burner by means of compressed air, the oil being thus consumed in the form of an extremely fine spray. During the last few months experiments have been tried at the works of Messrs. De Bergue and Co., of Manchester, who were the first to adopt the Lucigen light with the view of applying it for the heating of rivets, and a special furnace has been constructed—also Hannay's patent—which has been called the "Pyrigen," which has been worked in conjunction with the Allen pneumatic rivetter, manufactured by Messrs. De Bergue, and of which a full description has been given in THE ENGINEER. The "Pyrigen" is what may be termed a regenerative and radiative oil furnace, and after several modifications on the original design, it has been constructed in the form of an oblong brick-lined oven with an arched roof, in which there is an air space with inlets at the furthest end from the heating flame. A Lucigen lamp is attached to the furnace at the opposite end, and the flame projected into the interior of the furnace; there are also air inlets round the opening for the flame, through which cold air is drawn in, and the air, which has entered through the inlets at the opposite end after being heated as it passes between the roof and the brick lining, also enters the furnace in close proximity to the flame. The compressed air for working the lamp is derived from the same source as that which works the pneumatic rivetter, and it requires about 20 minutes to get the furnace into full working order. By that time the whole of the brick lining is at a red heat, which is constantly kept up, and rivets can be placed in the furnace and rapidly heated as required. So far as the actual cost of working the furnace is concerned, it has so far proved to be much about the same as an ordinary coal furnace, but the "Pyrigen" furnace presents manifest advantages in that it is portable and can be readily put down close to any work where it is required, whilst for stage work it is a very great improvement upon the coal furnace. I understand that similar furnaces are to be put down on trial at one or two other large works in the district, and the patentees assert that it can be worked very much more economically than the ordinary coal furnace.

A very handy light wheel cutting machine has just been introduced by Messrs. Chas. L. Baker and Co., of the Cornbrook Telegraph Works, Manchester. This machine, which is especially adapted for cutting small wheels in brass and gun-metal, is very compact in its arrangement and extremely simple in its construction and working, and requires very little power to drive. To ensure accuracy the dividing plate is set in a conical bearing so that it cannot work loose or out of the centre, and the cutter is mounted in a spindle turning between centres, the spindle being movable in a V slide which feeds the cutter by means of a handle working the slide. The machine can also be adapted for cutting racks up to 3ft. or more in length by placing a long V slide in the bed of the machine, the slide in which the rack is held being movable and mounted with a dividing plate at the end for the purpose of cutting the rack. The whole machine is driven by an overhead motion by means of a band from the main shafting on to a grooved fly-wheel, and there is a special arrangement for keeping a sufficient tension on the driving by means of a loose pulley with balance weight.

In the coal trade there has been a moderate business doing up to the holidays, owing partly to the extra orders which are given out in anticipation of the usual stoppage of the pits, but the actual condition of trade generally is only dull, and in the Manchester district there has, with the commencement of the month, been a further reduction in prices, the leading Manchester firms having reduced their pit, wharf, and delivered rates for all descriptions of house-fire coal 5d. per ton; a similar reduction has also been made in some of the screened coals for steam and forge purposes, but engine classes of fuel remain unchanged. In other districts outside the Manchester radius there is no present announced reduction in prices, but in some classes of round coal there is a weakening tendency which will no doubt lead to some giving way, and just now pit prices can scarcely be quoted, as with most of the pits stopped there is little or nothing doing.

For shipment, although here and there some collieries have been busy with orders, there is generally only a quiet demand, and some very low prices have been taken to effect sales.

Barrow.—There is again a quiet tone in the hematite pig iron trade, and the Whitsuntide holidays this week have accentuated the position. Buyers and sellers have alike temporarily withdrawn from the market. There is every probability, however, that the demand both from home and foreign sources will improve during the course of the next few weeks, as it is known that large parcels of iron are required for delivery during the season. The position of makers is unchanged. They are busy, and have orders on hand which will in all probability keep them busily employed during the remainder of the season, apart from any new orders. There is no doubt that large deliveries are required by steelmakers, who are using a greater weight of metal than for some time past. The value of pig iron is steadily maintained at 44s. to 45s. per ton net f.o.b., and even second-hand dealers who have shown a disposition to clear out their stocks have been selling within 6d. to 1s. per ton of the quotations of producers. Stocks are comparatively large, though they do not represent more than two to three months' deliveries. The steel trade is brisk, and there is anything but a better demand for rails, which are in heavy output, and which have been very fully ordered both by home and foreign buyers. The demand for the heavy sections of rails is particularly good, and prices are firm at from £4 2s. 6d. to £4 5s. per ton net f.o.b. The business doing in blooms is not so large as it has been, but makers already hold a large number of orders, and there is plenty of enquiry. Prices are quoted at from £3 15s. to £3 17s. 6d. per ton net f.o.b. Billets are in good enquiry at about £4 per ton. A fair trade is being done in bars, which are largely used for tin-plate purposes. The department in which steel plates and angles are made for shipbuilders is not well employed, although orders have been executed which have demonstrated the fact that so soon as a revival in the shipbuilding trade takes place this will be a very important and active industry. The shipbuilding trade, however, remains very quiet, and although several important orders are on the *tapis*, none of any importance have lately come to the yards of local builders. There is more hope of a very good trade in engineering, and particularly in the marine department, but boiler-makers, forge works, steel casters, and railway rolling stock builders are very indifferently employed. The finished iron trade shows no new signs of life, and makers are very indifferently supplied with orders. Iron ore is still quiet in tone, the deliveries now being made having been arranged for well ahead on standing contracts. Prices show no variation, being still quoted at from 8s. 6d. to 11s. per ton at mines. The coal and coke trades are comparatively busy, and deliveries are regularly maintained. There is a large consumption for steam purposes, and a good demand is springing up on shipping account.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

I INFORMED you some time ago that the Sheffield houses had decided not to tender for the 150,000 sword-bayonets of the Enfield-Martini type recently asked for by the Government. This news has since been confirmed by the placing of the order with Messrs. Wilkinson and Son, of London. This firm have a well-established reputation for sword making, and in their hands there is not the slightest doubt that the new sword-bayonet will be a thoroughly sound weapon. The blade and tang are to be made in one solid piece of high-class crucible steel, to be supplied by Messrs. Thos. Firth and Sons, of Norfolk Works, Sheffield. The new weapon, which will have to stand a much severer test than has yet been imposed, will be under 1 lb. in weight; the length of the blade will be 18½in., and the length from the shoulder to the tang, 4½in. It is a matter for congratulation that the work has been undertaken by a first-class English house.

Messrs. John Brown and Co., Atlas Steel and Ironworks, have obtained an order for the armour-plating for the screen bulkheads of the Nile and Trafalgar. This firm are well employed upon the manufacture of the new patent ribbed furnaces for marine boilers. Messrs. Clarke, Cammell, and Co., Cyclops Steel and Ironworks, are in receipt of an order for several thousand tires for the Patent Shaft Company, for use on the Indian State Railways. This has of late been a very important market for all classes of railway material, for which there continues to be an active demand, particularly in wheels, springs, axles, and tires, as well as in some descriptions of rolling stock.

The Woolwich authorities are about to place an order for 3560 6in. and 360 8in. armour-piercing shells. This work will probably come to the Sheffield houses, several of whom are now making steel projectiles for the Government. It is freely stated here that the officials at Woolwich are making strenuous exertions to have the production of steel projectiles carried on largely at the Arsenal. An expert tells me that this trade is peculiarly and appropriately a Sheffield trade, and that the Government cannot possibly conduct it successfully and profitably to the nation at such a distance from the coal and iron fields. Sheffield workmen are keenly interested in this further development of official enterprise, to say nothing of Sheffield manufacturers, who have expended much thought and vast expenditure to the production of this and other war material.

A very moderate business is reported in the cutlery, plating, and several other light industries, though one or two houses have no lack of work. Little is doing in table knives, and the spring knife branches are also quiet. For light edge tools the continental markets, particularly Germany, continue to be productive of good orders, and surgical instrument makers are also fairly well off. Generally, however, business is more languid in the old staple trades than was anticipated, and this has caused the Whitsuntide holiday to be somewhat prolonged by the cutlers and platers. In mining tools, picks, spades, and specialities for military purposes in entrenching tools and similar appliances, several firms are well employed both on home and foreign account.

On the 1st of June the first summer reduction in the price of coal took place. The leading South Yorkshire firm, who send the largest tonnage by rail to the metropolis, now quote as follows:—best Mortomley coal, 13s. per ton; thin seam, 11s. 8d.; brazils, 10s. 5d.; nuts, 10s.; brights, 10s.; common house coal, 8s. 9d. London took last year, from this single colliery company—Messrs. Newton, Chambers, and Co., Thorncliffe—no less than 312,708 tons, an increase of 37,171 tons over 1884.

The holidays have been very generally enjoyed this Whitsuntide, particularly on Tuesday, when the local railways were in a state of congestion, throwing expresses from one to two hours' late. Very large numbers of Sheffield artisans visited the Manchester and Saltaire Exhibitions. Work has not yet been generally resumed, and there seems every likelihood of the men making a week of it.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

OWING to the Whitsuntide holidays there was but a poor attendance at the Middlesbrough iron market on Tuesday last, and the amount of business transacted was very limited. It is somewhat difficult therefore to determine the exact present value of pig iron. The prevailing tone is, however, tolerably cheerful, and last week's advanced rates are at least maintained. For prompt delivery of No. 3 g.m.b., 34s. per ton was on Tuesday the lowest accepted by merchants, and 3d. more was required for delivery over the next few weeks. Makers are still unwilling to commit themselves, and will not accept anything less than 35s. for immediate delivery. Seeing that there is some improvement in the demand for finished iron and steel, and that pig iron stocks are decreasing, makers will probably obtain the prices they ask if they remain firm a little longer.

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

Most of the transactions in Cleveland warrants still take place at Glasgow. At the beginning of last week, the lowest price accepted was 34s. 6d. per ton; by Friday it had increased to 34s. 8d.; and on Tuesday the market price was 35s.

The stock of pig iron in Messrs. Connal and Co's Middlesbrough store decreased 683 tons last week.

Shipments are proceeding at a satisfactory rate. The quantity of pig iron which left the port of Middlesbrough between the 1st and the 28th ult. was 71,170 tons; and of manufactured iron and steel 54,675 tons.

Finished iron makers have booked a few fresh orders during the last few days, but they are not able to command better prices, owing to the great competition within the district, and also from elsewhere. Quotations on Tuesday were as follows, viz.:—Ship plates and common bars, £4 10s. per ton; best bars, £4 15s.; and ship angles, £4 7s. 6d., all free on trucks at makers' works, less 2½ per cent. discount. Some large orders for steel rails have lately been placed, and quotations are somewhat firmer. Steel ship plates are offered at £6 5s., and angles at £5 15s. per ton at makers' works.

The accountants to the North of England Board of Arbitration have just issued a certificate relating to the two months ending April 30th. The average net selling price of manufactured iron of all kinds appears to have been £4 13s. 4d. per ton, as against £4 13s. 4·28d. for the two months ending February 28th last.

The conversion of two-cylinder compound marine engines into triple or quadruple expansion ones goes on apace at the ports on the North-East coast; and it is not unlikely that before long all the marine engine builders will be exceedingly busy with work of this kind. The Central Marine Engineering Company, of Hartlepool, has just received an order to convert the engines of the steamer Suez, belonging to Messrs. Nelson, Donkin, and Co., of Newcastle, into quadruple engines. This is the first time that this has been done at the works referred to, or indeed at Hartlepool at all. All previous conversions have been to triples only. New boilers will be constructed of steel plates, and calculated to stand a very high pressure of steam. The present cylinders will be removed, and four new ones substituted. The work is being carried out under the superintendence of Mr. Jno. Rankine, the engineer to the above-mentioned firm.

Messrs. Blair and Co., of Stockton, have so much work in hand that they have considerably increased the number of men in their employment, and are working some of them by night. They are putting engines into the steamer Electrician, which was lately launched from a Tees-side yard.

A large iron sailing ship, called the Southgate, is at present in the dock at Middlesbrough. She is bound for an Australian port, and her cargo will consist mainly of railway material from the works of the Darlington Steel and Iron Company. Another similar vessel, and for the same destination, is loading rails and fish-plates from the works of Bolckow, Vaughan, and Co.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron warrant market has been fairly active during the week, and the rates comparatively firm. Current business is moderate in amount, but the condition of the speculative market tends to firmness in price. The past week's pig iron shipments were not very encouraging, being 7408 tons as against 9887 in the same week of 1886. They included 700 tons to the United States, 1012 to Canada, 950 to Italy, 300 to Australia, and smaller quantities elsewhere. It is expected that the shipments to Canada will be large in the next week or two, and that afterwards they will be reduced to very small proportions, if they do not cease altogether. The month of May shows a decrease of about 13,000 tons in the shipments compared with those of the corresponding month of last year, and the total shipments from Scotch ports to date now exhibit a decrease of 820 tons in place of the considerable increase that existed up till the end of April. There have been inquiries for small lots of pigs this week for Canada and elsewhere, but the volume of the foreign trade is unsatisfactory. There is no change in the amount of the production, but the increase in stocks in the warrant stores continues.

This week makers' pigs are quoted as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 48s.; No. 3, 44s.; Coltness, 53s. 6d. and 44s.; Langloan, 50s. and 45s. 6d.; Summerlee, 52s. 6d. and 42s. 6d.; Calder, 49s. 6d. and 42s.; Carnbroe, 43s. 6d. and 40s.; Clyde, 46s. 6d. and 41s.; Monkland, 43s. and 39s.; Govan, at Broomielaw, 43s. and 39s.; Shotts, at Leith, 48s. 6d. and 45s. 6d.; Carron, at Grangemouth, 52s. and 44s. 6d.; Glengarnock, at Ardrossan, 47s. and 40s. 6d.; Eglinton, 42s. 6d. and 38s. 6d.; Dalmellington, 43s. 6d. and 40s.

Exporters of Scotch pig iron to Canada are allowed to June 30th to deliver in that country quantities of pig iron free of the extra duty which is to be imposed. As a consequence, the shipments are now particularly large. The firms who are engaged in the construction of steel bridgework for the Dominion have been advised that the whole of the material of this description that had been contracted for previous to the promulgation of the new tariff will be admitted at the old rates.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THERE is a good deal of ferment in the colliery world respecting the provisions of the new Mines Bill, and before the 9th prox. I expect all objections will be formulated. It is contended that though blasting in the South Wales collieries is not positively forbidden, yet the clauses are so worded that practically the Bill will be prohibitory on this head. This, it is understood, would close 20 per cent. of the collieries, and lead to the paying off of 15,000 colliers. I find, amongst the most practical colliers, that blasting in the steam coal collieries cannot, in their opinion, be dispensed with. The Welsh coal is harder than that of the North, hence the little opposition raised in the northern coal field. In the Welsh coal field the cessation of blasting operations would stop at once the enormous outputs, and present prices could not be retained. The result would be a marked increase, and those in favour of prohibition say that the ultimate end would be favourable to the Welsh coalowners and colliers. This is the other side of the question.

There has been another good week, and the export has been large, though not quite up to late totals. Prices, however, are evidently on the ascending scale, and any little flush will bring about the desired advance. Present prices of steam vary from 7s. 9d. to 8s. 6d. Some of the large coalowners command the best price, but this is still only 3d. per ton above the prevailing quotation. Rhondda No. 3 continues to command 8s. 3d. per ton, contrary to the opinion of most buyers; but the fact is that the limited area of this special coal is such that the wonder is that this low price is retained. This coal and the four-feet give Wales its position in the world, and, as a coalowner observed lately, when they are gone the principality will be no better off than the rest of the country.

I find that during the northern strike North Wales has had its share of business. The trucks on the Cambrian Railway tell a tale.

Coke remains in fair demand at late quotations. Pitwood is a little better. Present prices from 13s. 6d.

The Barry Dock contract is going ahead well, and September, 1888, promises to see it finished. This will be good work, considering its extent. The dock area is 73 acres, basin 7 acres, and the timber pond 23 or 24 acres.

A private meeting of the Sliding Scale Committee was held in Cardiff on Saturday last, when Sir Wm. T. Lewis occupied the chair, and there was a good muster of coalowners and representatives.

In the iron trade a moderate amount of business is being done, but the shipping list is not so far much burdened with list of shipments. The principal this week have been 1100 tons to New Orleans and a cargo to Norway. Rail quotations are from £4 13s. 4d.

The tin-plate trade is unchanged. About this time every year of late it has been the habit to circulate rumours of American competition, which generally ends with the rumours. This year the rumour is stronger than ever, and it has not been without some effect on the market, and buyers in some cases have been able to place contracts for future deliveries at current quotations. As a rule the market is firm, and last prices well maintained. The lowest cokes are selling at 12s. 9d., and from this to 13s. 3d. for best brands are common figures. Bessemer, 13s.; Siemens, 13s. 6d.

Charcoals are again dull at prices varying from 13s. 9d. to 15s. 9d. Ternes are active at 13s. 6d. to 13s. 9d. Swansea sent away 49,000 boxes of tin-plates last week; 3000 tons are booked for Baltimore alone this week. The "lumpers" are giving some trouble at Bristol. Extensive machinery for rapid and effectual unloading having been erected at Avonmouth Dock, the grain porters struck, and substitutes had to be telegraphed for from Liverpool. In the end the men have gained their point.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

NO change for the better has shown itself during the week in the condition of the iron trade of Rheinland-Westphalia, but rather the contrary, for some articles have shown a weaker tendency. Strange as it may appear, the Silesian market has not yet been so depressed as would have been imagined after so severe a shock, which can only be accounted for by the optimistic notion, that sooner or later the Russian duties will be obliged to be lowered, and by the rolling mills and forges having full employment, with orders still coming in at the greatly enhanced price of M. 127·50 p.t. for bar iron, achieved by the combination bureau, which is paid without a murmur. But doubtless in a short time the full effect of the blow, and a still further one of an increased duty on coal into Russia, which will then amount to M. 4 p.t., the decree for which only awaits the Emperor's signature, will soon be felt and the reports become gloomy enough. It is said that the object aimed at by the Russian Government in laying on these heavy duties is to drive the whole of the iron industry towards the south, but it is a great pity to abandon and sacrifice the fine iron ore mines of Russian Poland to such a policy. At all events it must make a great difference to the Silesian iron trade.

The Belgian iron trade was very firm until the strikes assumed such proportions, but now it is disorganised, and time must show what is to be the result. This strike is beginning to give signs of an ugly feature, and has now extended in an acute form to all the three coal basins and to such works as Cockerill and Co., Sclessin, Ougrée, and other establishments and mines which were paying reasonable wages, which indicates that it is as much an anarchical as an economic strike, the indubitable general starvation wages being the primary incentive. The French market is very flat indeed. The attempts of the large holders of iron at Paris to raise the prices came too late, and they are now much depressed.

The demand for ores in the Siegerland has much diminished, and the prices during the month of May have not inconsiderably receded, and are now noted at M. 8·10 to 11·40 to 12 for very best sorts on trucks at delivery station. The State Railway Administration has decreed that the special low freight tariff for ores to Westphalia, and cokes therefrom to the works shall continue in force till the end of 1888. This is very agreeable for ironmasters, namely, as soon as their business becomes dull to be assisted in this paternal manner at somebody else's expense; but what a light it throws on the continental iron industry in general! Not satisfied with being protected by duties, but must have further relief in cheaper freights, whilst their English rivals have to contend against exacting railway directors and dearer wages, yet, with the raw materials at the same prices, as these "Notes" from week to week show, the English can produce and sell cheaper than the continental works. The former may look with satisfaction—it may be said with pride—on this achievement, yet many excellent people in England, not practically acquainted with the real state of things, are continually saying more technical education on continental lines is needed if England is to compete successfully with the foreigner. It is not that which is so much wanted, but the mercantile classes, from the very lowest clerks upwards, need a more thorough, better, broader, and higher education. When that is attained, no rival ever need be feared, as far as continental technical education is concerned But this is a digression.

The shipment of Spanish ore was brisk, and 96,924 tons were despatched last week, the prices ranging from 6s. 6d. to 7s. This year, up to the middle of May, 1,681,340 tons of ore have been shipped at Bilbao.

The stocks of pig iron are increasing. In Westphalia, however, prices have been pretty well maintained, while in the Siegerland they have gone down. This has, of course, brought to the front the idea of a combination bureau in the latter district for the sale of pig iron, and meetings to arrange for one have been held and a plan agreed to; but those who know the Sieger country cannot anticipate much success for it. There are signs at this moment, nevertheless, that a good deal of forge pig will shortly be required, and several of the important rolling mills, with good orders on the books, have already contracted for quantities for the third quarter. The best brands have lost M. 2, and now fetch M. 43 to 44, while the same in Westphalia are maintained unchanged at M. 48 p.t. The price of coke is to be raised after the 1st June, and this will probably give a fillip to prices. Spiegel has also lost M. 1 to 1½ since the end of April, and the trade in it is flat at this moment, although large quantities have been contracted for. The reason for this is that freights from German and Belgian ports to America are unfavourable just now for heavy goods, and so less is exported, much to the annoyance of makers here, because it gives the English an advance, and by way of Rotterdam there are no practical cheap loading or unloading arrangements along the whole route. They are conspicuously absent in Germany. The best brands, 16 p.c. Mn., cost M. 56, and so on downwards to 48 p.t. On the whole the demand for crude iron is anything but brisk. For the present the rolling mills and forges have sufficient work to keep them on regularly, and when not on finished sorts, then on part manufactures as blooms, uses, &c., which are going in quantities to Belgium, France, and Italy, at prices which are remunerative. There is a better demand for boiler and thick plates at satisfactory prices, but this cannot be said of thin sheets, which have fallen in price, and during the week have been held up as M. 130 p.t. For building purposes the demand has not diminished, and the mills can keep regularly going. Concerning wire rods, there is little to note. Demand and prices are unchanged; but still a convention is being discussed, which is always a weak sign. There is little new in railway materials. The English and Belgian firms tendered higher than the German for 3340t. of steel rails at Bromberg on the 20th ult., Krupp's price being M. 112, and that of the Bochum Union M. 112·50 p.t. at works. This is about a mark higher than the prices offered a month ago. The wagon works are in the same position they were when last mentioned. With the exception of the pipe foundries, the other construction shops have a little more to do, and orders are coming a little more freely to hand, but great complaint is expressed about the low prices the work must be taken at.

An order for 60,000 side arms, newest pattern, for the Saxon army has just come to Solingen. It is devoutly to be hoped that some means will ultimately be found to keep the English Government order for 150,000 in the country. Solingen is overburdened with work of this kind for some time to come, so if the officials should conceive the unpardonable idea of trying here, they would doubtless have to pay pretty stiffly for it. If one party cannot and the other will not, would it not be possible to establish a small inexpensive company to make this first lot to afterwards compete with Solingen in foreign markets? In Pesth an expensive works is being established to make 400,000 rifles, but when that order is finished the company will be worse situated than one for manufacturing swords would be.

The increase of duties on fuel imported into Russia, shortly to come into force, is to be 1 gold kopek per pud on coal entering Baltic ports, entering by land 2 gold kopeks per pud, and entering the Black Sea ports 3 gold kopeks per pud, while cokes are to pay in the same way 1½, 3, and 4½ gold kopeks per pud. As heretofore, fuel entering White Sea ports is to be free. According to this, English coal will pay 2s. and German 4s. p.t. duty

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, May 21st.

BROKERS have inquiries this week for several large blocks of Bessemer pig iron, spiegel, steel blooms, steel rails, and cargo scrap. The recent drop in prices has brought out a few inquiries; but up to this hour business for all material of the kind named has not reached more than 30,000 tons, which brokers say is a good start. Scotch iron is moving with more vigour at 20 dols. for Eglinton, 21 dols. for Glengarnock, and 21·75 dols. for Coltness. Bessemer is quoted at 20 dols. to 20·50 dols.; English spiegel, 20 per cent., 27·25 dols. English steel rails, 41 dols. at Gulf Ports; offers at 40 dols. have been made. Rail blooms, 29 dols. Wire rod bids are in at 40 dols. Old rails are going into stock, on account of low prices. American buyers will likely make heavy purchases of material during the month of June. To-day's telegraphic advices from the interior show that no change has come over the markets, that merchant bars are dull, that competition is very active in both iron and steel mills, and that the inquiry and orders arriving are barely sufficient to preserve prices at the strong limits reached during April. The car and locomotive works and shipyard requirements, as well as bridge-building requirements, are strong factors, and all kinds of material used in these establishments are bringing good prices. Foreign scrap is sold at 20 dols. to 20·50 dols. The distribution of tin-plates is not active. Copper is strong at 10 cents. Lead has advanced slightly; quotations, 4·30 to 4·40. Spelter, 4½. The stocks of tin-plate are only fair, and the leading houses anticipate an improvement when the summer demand sets in. The traffic returns from several of the leading railway systems continue to show an increasing volume. The demand for all kinds of heavy machinery and for cotton and woollen machinery is sufficient to keep machinery manufacturers busy, and a full summer's work is now assured.

Labour strikes are somewhat threatening. The number who have gone out within ten days foots up about 10,000, mostly in the building trades. The coal companies here report the trouble over in the anthracite regions. There is great activity in real estate in and around the city, and building operations are taxing the full building trade force. The extraordinary influx of immigrants is favourably regarded by banking and manufacturing interests as a probable offset to the growing power of trades unionism and the advancing tendency in wages. A leading banking firm has just issued a sort of congratulatory circular, advising the employing interests of the country to encourage immigration of this character for the purposes named.

NEW COMPANIES.

THE following companies have just been registered:—

Agricultural and Industrial Association, Limited.

This company was registered on the 21st inst., with a capital of £6,000,000, in £10 shares, 500,000 of which are to be 6 per cent. cumulative preference shares. It proposes to transact agricultural, industrial, commercial, mercantile, banking, discount, exchange, financial or other business, trade or operation; to acquire real or personal property and to develope the same. The company also proposes to add philanthropy to its somewhat varied programme, power being taken to provide for the welfare of persons in the employment of the company, or formerly in its employment, and the widows, children, and dependents of such persons, by granting money or pensions, making payments for or toward insurance on the lives of such persons, providing schools, reading-rooms, or places of recreation, but nothing herein contained shall authorise the company to carry on life insurance business. The signatories who subscribe for one preferred share each are as follows:—

	Shares.
Napo Barone Onofri, 35, Half Moon-street, Piccadilly	1
John Rush Bailey, 28, Osnaburgh-street, Regent's Park	1
C. E. Gudgeon, Grenville, Cavendish-road, Clapham Park	1
S. Philippart, 35, Half Moon-street, engineer	1
Simon Philippart, 35, Half Moon-street	1
Henry C. Barker, 23, Faunce-street, Kennington Park, S.E.	1
W. L. Greenfield, 8, Studley-road, Forest Gate	1
J. Mansel Jones, 3, Albert-road, Dalston	1

The number of directors is not to be less than five, nor more than twenty-one; qualification, £2000 in preference shares; the first are to be appointed by the subscribers, who act *ad interim*. The chairman is to receive £500 per annum, the deputy-chairman—if any—£300 per annum, and each ordinary director £200 per annum. A director is to vacate his position in the event of bankruptcy, lunacy, or similar incapacity. The subscribers are to appoint a general manager, who is to remain in office until 1897. The surplus net profits remaining after payment of the preference dividend will be divided as follows:—5 per cent. to the directors, 5 per cent. to the general manager, 45 per cent. to the preference shareholders, and the remainder to the ordinary shareholders.

New Gülcher Electric Light and Power Company, Limited.

This is a reconstruction of the Gülcher Electric Light and Power Company, Limited. It was registered on the 25th inst., with a capital of £70,000, in £1 shares. The subscribers are:—

	Shares.
*D. de Castro, 6, New-square, Lincoln's-inn, barrister	1
*S Studd, Bedford House, Upper Norwood	1
W. C. Mountain, 2, Rothsay-villas, Wandsworth, engineer	1
*Wm. Wallace, 27a, Old Bond-street, architect	1
*Major J. W. M. Cotton, 28, Ampthill-square, N.W.	1
*T. Lloyd, 53, New Broad-street, newspaper proprietor	1
*H. Grewing, 14, Austinfriars, merchant	1

The number of directors is not to be less than three, nor more than eight; the first are the subscribers denoted by an asterisk; qualification, 250 shares; remuneration, £1200 per annum, or such larger sum as shall be equal to 10 per cent. per annum of the net profits, not exceeding £2000 in one year.

Aluminium Syndicate, Limited.

This syndicate was registered on the 30th inst., with a capital of £30,000, in £10 shares, to manufacture aluminium in accordance with the invention of Dr. Edward Caspar Kleiner Friertz, of Zurich, for which patent rights were applied for on the 29th June, 1886, No. 8531, by Francis Ignatius Ricarde Seaver, of the Conservative Club, St. James'-street. The subscribers are:—

	Shares.
*G. Cawston, Hatton-court, E.C., barrister	1
H. V. Higgins, 130, Sloane-street	1
C. A. Scott Murray, J.P., Marlow, Bucks	1
*F. J. R. Seaver, F.R.S., Conservative Club	1
A. H. Bourke, 18, Throgmorton-avenue, stockbroker	1
J. O. Maund, 204, Regent-street, stockbroker	1
*S. Charles Newton, 1, Davies-street, Berkeley-square	1

The first committee of management consists of the subscribers denoted by an asterisk and Messrs. Ludwig Mond, of Droitwich, and R. Nevile, of Grantham. Dr. Edward Kleiner is appointed first manager and electrical engineer at a salary of £700 per annum.

Anglo-Ottoman Cotton and Woollen Mills Company, Limited.

This company was registered on the 20th inst., with a capital of £250,000, in £5 shares, to acquire a concession granted by the Sultan of Turkey to Almed Refik Bey, Rechid Bey, and Refik Bey for the purpose of erecting and working a manufactory for the production of cotton and woollen fabrics at Constantinople and its provinces. The subscribers are:—

	Shares.
John Musgrave, Bolton, engineer and cotton spinner	1
R. A. Dobson, Bolton, engineer	1
G. Thomas, Bolton, engineer and merchant	1
Emin Effendi, 7, Union-court, Consul-General for Turkey	1
A. E. Barthel, Hotel Metropole, mechanical engineer	1
C. Akers, 11, Abchurch-lane, chartered accountant	1
Osmond Maskell, 49, Coverdale-road, N.W., accountant	1

The number of directors is not to be less than four, nor more than twelve; qualification, 50 shares; the subscribers are to appoint the first; remuneration, £200 per annum each.

Clough Cotton Spinning Company, Limited.

This company was registered on the 25th inst., with a capital of £40,000, in £5 shares, to acquire the Clough Mill, Springhead, York. The subscribers are:—

	Shares.
*J. F. Andrew, Oldham, cotton-waste dealer	1
*W. Buckley, Oldham, cotton spinner	1
*G. E. Andrew, Lees, cotton spinner	1
*R. Hopwood, Harpurhey, mill manager	1
*S. Wroe, Lees, butcher	1
J. B. Lord, Lees, printer, &c.	1

The subscribers denoted by an asterisk are the first directors.

THE MINT.—The report of the Deputy-Master of the Mint for 1886, which is now issued, states that during the year no gold had been coined, the Mint having been exclusively engaged on silver and bronze coinage, the value of the former being £417,384, and of the bronze coins £51,669. The number of half-crowns coined was 994,752, and of florins 592,020; while the shillings struck amounted to 1,774,080, and the sixpences to 2,724,480 in number. The number of threepenny-pieces coined was 6,150,408.

LIVERPOOL ENGINEERING SOCIETY.—At a recent meeting of this Society a paper was read by Mr. J. F. Waddington on "Submarine Vessels." In commencing the paper the author gave a brief history of what had been done in submarine navigation. Few persons, he said, would be aware that the idea of a vessel to travel under water was anything but a new idea. There were records of submarine vessels as far back as 1648, and a very interesting series of experiments were made by Fulton in 1801. Submarine vessels, he stated, were used in the American Civil War, and numbers of patents had been taken out in America, none of which, however, had come to anything. He then referred to the submarine vessel, the Resurgam, designed by Mr. Garratt, and tried in the Birkenhead Float in 1879, and also the Nordenfelt boats, which were also from Mr. Garratt's designs. His own submarine vessel, the Porpoise, which was tried last year before the representatives of the British and foreign Admiralties, was then described. She was, he said, 37ft. long by 6ft. 6in. beam, and was arranged to be propelled by electricity. The Porpoise was submerged when under way by means of inclined planes, which, when the buoyancy of the vessel had been sufficiently reduced by taking in water, were set over at an angle, and so guide the vessel below the surface. He also described the horizontal propellers working in the vertical tubes used in his boats for the purpose of driving below in cases of emergency when there was no way on the boat. The great danger with submarine vessels of suddenly diving by the head when going at any speed was then dealt with, and he showed how, by means of a horizontal rudder arrangement, actuated by an automatic electric steering gear, he had met this danger. Compressed air for consumption by the crew was, he said, carried in two compartments at the ends. For the propulsion of the vessel and for driving the various machinery on board the vessel, the electricity was stored in forty-five accumulators of 660 ampère hours capacity. The maximum current taken by the motor was 66 ampères, the electric motive force being 90 volts, thus giving an electrical horse-power of 7·96; with a motor of 81 per cent. efficiency, the actual horse-power would be 6·77. The author stated the speed of the boat with this power would be about eight miles per hour, at which speed she would be able to run a distance of eighty miles.

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.

17,169. PNEUMATIC DREDGERS, J. and E. Vernaudon, London. [Received 25th May, 1887. Antedated November 10th, A.D. 1886. Under International Convention.]

25th May, 1887.

7510. HEATING RAILROAD CARS, &c., J. H. Sewall, London.
7511. FURNITURE CASTORS, F. and H. Matchett, Birmingham.
7512. SOLITAIRES, G. Pritchard, Birmingham.
7513. FELTING WOOLLEN THREAD, T. Tschieret, London.
7514. CHILLED GRAIN used for ROLLING IRON, C. Akrill, London.
7515. FILTERING and LIXIVIATING PRESS, C. A. Koellner, London.
7516. MAKING, &c., TILE FENDERS, H. Godwin and W. Hewitt, Hereford.
7517. SAWS, &c., T. Tyzack, Sheffield.
7518. MANUFACTURING PURE HYDROGEN, J. Belou, London.
7519. TREATMENT of ORES, J. Belou, London.
7520. MACHINERY for SPINNING, W. Tatham, London.
7521. ROTARY ENGINES, J. A. Wade and J. Langdon, London.
7522. BURNISHING BOOTS and SHOES, H. H. Lake.—(*E. M. Parkhurst, United States.*)
7523. HOSE and HALF HOSE, G. Templeman, London.
7524. MANUFACTURE of PIGMENT, H. H. Lake.—(*J. P. Perkins, United States.*)
7525. AIR COMPRESSING APPARATUS, H. H. Lake.—(*U. Cummings, United States.*)
7526. MANUFACTURE of SCREWS, H. H. Lake.—(*W. R. Clough, United States.*)
7527. DYNAMO-ELECTRIC MACHINES, R. M. Hunter, London.
7528. CLOTH-FOLDING FRAMES, A. W. and H. W. Brewtnall, Greenheys.
7529. CAPS employed in SPINNING, J. E. and E. W. Sykes, Halifax.
7530. ELECTRICAL TRANSFORMERS, J. G. Statter, London.
7531. VELOCIPEDES, J. Johnson, Rainhill.
7532. SURGEON'S COMBINED CHAIR and TABLE, A. J. Marston, London.
7533. CLEANING, &c., METAL PLATES, F. J. Clamer and J. G. Hendrickson, London.
7534. COMPOSITION for HEALING WOUNDS, R. M. H. Hicks, London.
7535. LEG REST, J. Lawrence, Brighton.
7536. LAMP, C. E. Gurnsey, London.
7537. SHOW CASES, E. J. Fletcher, London.
7538. NAIL-MAKING MACHINES, C. March and W. Dick, Glasgow.
7539. PORTLAND CEMENT, A. Smith, J. Robertson, and J. R. Andrew, Glasgow.
7540. MANUFACTURE of CLOTH, J. W. Martin, Halifax.
7541. TYPE WRITING MACHINES, F. D. Butler, London.
7542. VENT-PEG for BEER CASKS, &c., E. Birch, Manchester.
7543. FORM of FLUID METER, &c., A. B. Wilson, Holywood.
7544. SPINNING TOP, A. H. Valda, Chiswick.
7545. ORNAMENTING WATERPROOF FABRICS, I. Frankenburg, Greengate.
7546. HOLDER for RAILWAY TICKETS, C. A. Grant, London.
7547. HOLDER for SERVIETTE, W. Lyon, Strangeways.
7548. CURB KEYS for TELEGRAPH CABLES, J. Gott, London.
7549. METALLIC EASEL for PHOTOGRAPHS, &c., J. Deakin, Birmingham.
7550. WASHING, &c., FIBRES, E. B. Petrie and R. Wild, Rochdale.
7551. LOCKS, W. H. S. Aubin, Bloxwich.
7552. SPRADER or SPREADER, M. Smith, Gloucester.
7553. ELECTRO-MOTIVE FORCE of DYNAMO-ELECTRIC MACHINES, F. George, Dursley.
7554. NAVIGATIONAL SIGNALLING APPARATUS, C. E. Allan, Glasgow.
7555. AIR PROPELLER, J. and R. Crighton and G. C. Peel, Manchester.
7556. DYEING YARNS, K. Lockwood and E. L. Adamson, Halifax.
7557. AUTOMATIC COUPLING for RAILWAY WAGONS, E. Williams, Hulme.
7558. GEARING for EXTENSION RAILS of RAILWAY TURN TABLES, A. Whitaker, Leeds.
7559. COLLAR STUD, W. P. Greaves, Birmingham.
7560. INTERNALLY STOPPERED BOTTLES, H. M. Ashley, Sheffield.
7561. TABLE CUTLERY, W. Tyzack and J. Fee, Sheffield.
7562. BRAKES for VEHICLES, W. S. Laycock, Sheffield.
7563. INGOTS, &c., of SELF-HARDENING STEEL combined with other STEEL, F. W. Seaman, Sheffield.
7564. CARTRIDGES for ORDNANCE, G. Quick, London.
7565. EASY WORKING of DOOR LOCKS, &c., H. Adeane, Paddington.
7566. BALL BAGS, &c., H. Lintott, South Norwood, and H. T. Tallack, London.
7567. TIN, &c., D. Owen, London.
7568. WRITING PENS, G. T. Beilby, Midlothian.
7569. AUTOMATIC WEIGHT REGISTERING MACHINES, G. Kirkman, London.
7570. PROJECTILES for RIFLED GUNS, P. M. Parsons, London.
7571. FOUR-FOLD SECURITY MORTICE LOCK, J. Tuckett and G. H. Foster, London.
7572. HORSE-COLLARS, H. W. Loads and W. Armes, London.
7573. UNDERFRAMES or SILLS of METALLIC WAGONS, R Hudson, London.
7574. SHACKLES for CONNECTION and DISCONNECTION, S. S. Sugden, Woodford.
7575. FRICTION CLUTCH MECHANISM, A. J. Boult.—(*C. A. Backstrom, New Jersey.*)
7576. SPINNING MACHINES, A. McDonald, United States.
7577. ELECTRIC RAILWAY CARS, N. H. Edgerton, London.
7578. SASH FASTENERS for WINDOWS, H. Wilson, Liverpool.
7579. REFLECTORS, C. Hall, London.
7580. VELOCIPEDES, F. Tentschert and F. W. Minck, Switzerland.
7581. HAY-MAKERS, R., J., and H. Wilder, London.
7582. SUPPLYING OIL for LUBRICATING RAGS, J. W. Vine, London.
7583. RECEPTACLE for TOILET POWDERS, M. Wedlake, London.
7584. DOMESTIC FIRE-PLACES, H. Schallehn, London.
7585. LIFE PRESERVERS or BUOYS, F. Gregson, Bradford.
7586. CHENILLE CARPETS and RUGS, W. Adam, Kidderminster.
7587. AUTOMATIC REGISTRATION of MUSICAL COMPOSITIONS, W. H. Lucas and A. H. Morgan, London.
7588. HORSESHOE and other NAILS, A. J. C. Bannwart, London.
7589. EXTINCTION of FIRE, J. C. Merryweather, London.
7590. MACHINES for SHAVING SKINS, A. M. Clark.—(*E. L. C. Schulz, United States.*)
7591. TRANSMITTING VALUABLES, H. J. Haddan.—(*H. W. Woodruff, United States.*)
7592. REED ORGANS, H. J. Haddan.—(*J. B. Hamilton, United States.*)
7593. BUNGS, &c., for CASKS, R. Haddan.—(*P. Lescure, France.*)
7594. CONSTRUCTING ARTICLES for giving them LIFE-LIKE MOVEMENT, L. Brennan, London.
7595. LEVER-LIFTING and PRESSING APPARATUS, G. Perkins and G. T. Dunn, Newport.
7596. SCREW STOPPERS for BOTTLES, &c., T. Taylor, Birmingham.
7597. BOTTLES, &c. J. T. Smith, London.
7598. INTERNALLY STOPPERED BOTTLES, L. Vallet, Liverpool.
7599. SLUBBING, &c., FRAMES, S. Morris, London.
7600. GYMNASTIC APPARATUS, T. O. Knofe, London.
7601. STANDING ARRANGEMENT for CARDS, &c., S. Edwards, London.
7602. REELING MACHINES, T. Holt, Manchester.
7603. DETONATING SIGNAL APPARATUS for RAILWAYS, G. S Spencer, London.
7604. MAINTAINING a UNIFORM TENSION upon the ENDLESS DRIVING TAPES of SPINNING, &c., MACHINERY, A. T. Lawson and S. Dear, London.
7605. DIFFERENTIAL WHEELS used in DRIVING BOBBINS of REGULATING, &c., FRAMES, A. T. Lawson and S. Dear, London.
7606. FISHING STOCKINGS, A. S. Douglas, Edinburgh.
7607. ELECTRO-MAGNETS, H. P. F. Jensen, London.
7608. EXPLOSIVES, H. H. Lake.—(*Wohanka and Co., Austria.*)
7609. CERAMIC KILNS, F. Siemens, London.
7610. REGENERATIVE GAS LAMPS, F. Siemens, London.
7611. SUBMARINE CABLE GRAPNELS, &c., W. C. Johnson and S. E. Phillips, London.
7612. SHOW BRACKETS, A. V. Mayo and J. I. Lee, London.
7613. LIGHTING and HEATING by MINERAL OILS, L. Sepulchre, London.
7614. GAS METERS, L. E. Séquard, London.
7615. FRICTION GEAR, W. S. Lockhart, London.
7616. UMBRELLA FURNITURE, F. A. Ellis, London.
7617. OUTDOOR GARMENT for LADIES, H. W. Ahronson London.
7618. ELECTRIC TRANSFORMERS, &c., W. M. Mordey an d C. E. Webber, London.
7619. PURIFICATION of WATER, &c., C. J. Bühring, London.
7620. BUTTON-HOLE ATTACHMENTS for SEWING MACHINES J. Y. Johnson.—(*J. R. Hebert, New York.*)
7621. UMBRELLA, L. Phillott, London.
7622. FEED-WATER HEATERS, &c., C. A. Knight.—(*A. A. Goubert, United States.*)
7623. AUTOMATIC REVERSING MECHANISM, Sir E. Green, Bart., London.
7624. SECURING CORKS, H. H. Lake.—(*W. C. Van Vliet United States.*)

26th May, 1887.

7625. STRENGTHENING WHEELS, J. Berkeley, Belfast.
7626. FEEDING WOOL to CARDING MACHINES, J. Haigh, Halifax.
7627. AZO COLOURING MATTERS, I. Levinstein, Manchester.
7628. STEAM BOILER, &c., FURNACES, H. Walker, Birmingham.
7629. CRANK SHAFTS, &c., H. Foster, Newcastle-upon-Tyne.
7630. MEASURING HEIGHT, W. P. Ingham, Middlesbrough-on-Tees.
7631. WORKING of TRAINS, J. Forsyth and J. Fairless, Gateshead.
7632. CASTOR RIMS, W. Hughes, Birmingham.
7633. STRAIGHTENING, &c., WIRE, D. Smith, jun., Wolverhampton.
7634. ROUNDABOUTS, A. Ridge, Manchester.
7635. METALLIC BUTTON and FASTENER, E. Moore, Liverpool.
7636. TOY, J. T. B. King, Manchester.
7637. SANDING RAILS, F. S. Willoughby and H. Williams, Stockport.
7638. BLIND ROLLER BRACKETS, G. Whitehead, Birmingham.
7639. KILNS or DRYING FLOORS, B. P. Harris and A. Stagg, London.
7640. GRATE BARS for BOILERS, &c., R. Robson, Lower Wortley.
7641. ROUNDABOUTS, G. F. Lutticke, Brighton.
7642. CHECKING COINS, G. E. Sherwin, Birmingham.
7643. STARTING, &c., VEHICLES, J. and C. Merckelbagh, London.
7644. PAVING, F. Wicks, Glasgow.
7645. FASTENING BUTTONS, &c., G. J. Parkman, Birmingham.
7646. CONTROLLING the BUILDING of BOBBINS, T. L. Daltry, Manchester.
7647. FASTENING for BOOTS and SHOES, J. White, London.
7648. SPANNERS, J. K. Starley, London.
7649. CARRIAGES for OVERHEAD RAILWAYS, W. P. English, London.
7650. BEARINGS for JOURNALS of SPINDLES, F. Garrett, London.
7651. HYDRAULIC MACHINES for RIVETTING, H. Smith, Glasgow.
7652. THIMBLE and THREAD-CUTTER, W. H. Townend, London.
7653. GOVERNORS for STEAM ENGINES, &c., J. H. Dewhurst, Sheffield.
7654. ROTARY STEAM ENGINE, T. T. Kemp, London.
7655. SCREW-NECKED BOTTLES, W. J. Wheeler, Richmond.
7656. TROUSER SUSPENDERS, W. W. Taylor, London.
7657. TREATMENT of AURIFEROUS MINERALS, J. Weirich, London.
7658. VALVES and STEAM TRAPS, T. W. Baker, London.
7659. MINIATURE TARGETS, W. E Heath, London.
7660. LAMPS, C. M. Walker, London.
7661. SODA, W. G. MacIvy, London.
7662. IMPARTING MOTION to MACHINES, T. Bower, R. W. Bower, J. Blackburn, and F. Mori, London.
7663. BOXES for CARDS, A. C. Thomson and H. Nicholson, Glasgow.
7664. PRIMARY BATTERIES, L. N. Loeb, London.
7665. COMBINED BASSINETTES and PERAMBULATORS, R. L. Holt, London.
7666. HAT HOLDER, M. Emmanuel, London.
7667. SCORING PASTE and similar BOARDS for BOXES, &c., W. G. Bagnall and H. Bostock, London.
7668. REARING CHICKENS, J. Chilvers, London.
7669. NEUTRALISING the EFFECT of NICOTINE in TOBACCO, &c , J. Hickisson, London.
7670. STRIKING BELLS, J. Harrington, London.
7671. WHEELS, J. Harrington and J. Hooper, London.
7672. BLADES of WINGS of PROPELLERS, &c., F. J. Crossley, London.
7673. PORTABLE ZINCOGRAPH PRINTING PRESS, D. Collins, London.
7674. SENDING, &c , SIGNALS, G. and S. Jennings and E. G. Brewer, London.
7675. MUSHROOM ANCHORS, W. C. Johnson and S. E. Phillips, London.
7676. AUTOMATIC MUSICAL INSTRUMENTS, L. E. J. Thibouville, London.
7677. GAS-ENGINE, C. Davy, London.
7678. FACILITATING the ABSORPTION of LIQUIDS for MEDICINAL, &c., PURPOSES, A. Carcenat and L. Rivet, London.
7679. CLOSING of JARS, E. Deutsch, London.
7680. DELIVERING ARTICLES o UNIFORM SIZE and WEIGHT in EXCHANGE for COIN, F. J. J. Gibbons and H. Osborne, London.
7681. PURIFYING OIL, H. J. Haddan.—(*P. Schröder, Germany.*)
7682. SCISSORS, C. Hamann, London.
7683. ELECTRIC ALARM APPARATUS, E. Bettleheim, London.
7684. MEASURING LIQUIDS, T. Coldwell.—(*W. H. Coldwell, United States.*)
7685. KEYBOARD MUSICAL INSTRUMENT, A. L. Caldera, London.

27th May, 1887.

7686. BRACELETS and other JEWELLERY, E. Morin.—(*T. Walther, Germany.*)
7687. SHUTTLE GUARDS for LOOMS, &c., T. Calvert, Preston.
7688. RENDERING BROOMS NOISELESS, M. R. and R. V. Carden, London.
7689. WEAVING FABRICS, C. Brazil and J. E. Johnson-Ferguson, Manchester.
7690. WEAVING FABRICS, J. E. Johnson-Ferguson, Manchester.
7691. CASKS, G Perrott, jun., Cork.

7692. Raising Window Blinds, G. Creighton, Wolverhampton.
7693. Lubricators, J. L. Garsed, Halifax.
7694. Fence Wires, &c., D. McBride and J. Burdon, Glasgow.
7695. Wind Motor, R. and A. Moore, Nottingham.
7696. Ventilating Fans, W. E. Heys.—(*J. Steinberg, Germany.*)
7697. Traps, W. A. Ross, Belfast.
7698. Syphons, W. A. Ross, Belfast.
7699. Oil Cans, C. Gaul and T. Wolstenholme, Bradford.
7700. Ornamenting of Coffin Handles, J. Gordon, Birmingham.
7701. Soda, C. F. Claus, H. L. Sulman, and E. E. Berry, London.
7702. Stoppering Bottles, J. W. and H. F. Boughton, Hunningley.
7703. Carriages, J. Craigen, Keswick.
7704. Tobacco Pipe, D. H. Shuttleworth-Brown, London.
7705. Moving Ship Bottoms at Will, J. H. O'Connor, Littleton.
7706. Metallic Bedsteads, Cots, &c., L. H. Brierley, Birmingham.
7707. Electric, &c , Engines, W. W. Dunn, Birmingham.
7708. Kilns, N. R. Foster, Cowley.
7709. Teapots, &c., A. G. Thompson and W. P. Davis, Sheffield.
7710. Sheet Metal Piping, J. T. Key, Sheffield.
7711. Weighting Devices for Calenders, T. A. Crook, London.
7712. Pressing Cloth, J. Longtain, Leeds.
7713. Washing Coal Gas, J. H. R. Dinsmore, Liverpool.
7714. Illuminating Gas, J. H. R. Dinsmore, Liverpool.
7715. Velocipede Wheels, C. Allen and A. Rathbone, Liverpool.
7716. Steam Generators, P. Evans, Liverpool.
7717. Steam Generators, J. C. Stitt, Liverpool.
7718. Railway Rail Chairs and Fastenings, I. A. Perry, London.
7719. Piston Rods, S. S. Bromhead.—(*C. Rohn, United States.*)
7720. Telephone Switch, S. S. Bromhead.—(*C. A. Hitchcock, United States.*)
7721. Pocket Mitrailleuses, A. J. Boult.—(*L. Montlahuc,* ——.)
7722. Churning Milk, S. Dobson, Manchester.
7723. Heating Apparatus, O. Kruschki, Liverpool.
7724. Churning, W. Swarbrick and T. Houghton, Liverpool.
7725. Crushing Mills, C. W. Guy, London.
7726. Drying Machines, R. W. Deacon.—(*W. Maxwell, Java.*)
7727. Signal Cartridges, J. W. Dyer, London.
7728. Embossed Designs on Panels, W. J. Michels, London.
7729. High-speed Steam, &c., Engines, C. H. Benton, London.
7730. Cartridges for Blasting Coal, &c., H. Johnson, London.
7731. Clip Pulleys, J. Blackburn and G. J. Lampen, London.
7732. Overhead Railways, W. P. English, London.
7733. Dyes, J. Y. Johnson.—(*Farbenfabriken vormals F. Bayer and Co., Germany.*)
7734. Looms for Weaving, J. Y. Johnson.—(*H. R. Parmentier, France.*)
7735. Stopper for Bottles, A. J. T. Wild and J. S. Green, London.
7736. Tricycle and other Lamps, J. Smith-Brown, London.
7737. Photographic Printing, J. Harrington, London.
7738. Fabric for Shirt Fronts, &c., The British Xylonite Company and L. P. Merriam, London.
7739. Sewing Machines, G. Brewer.—(*P. Jansen, Belgium.*)
7740. Dyeing Fabrics, E. Boursier, London.
7741. Tram-cars, O. Ber, London.
7742. Exploding Arrangements of Submarine Mines, &c., E. P. Leresche, London.
7743. Supplying Fresh Air to Railway Carriages, A. A. Clarke, London.
7744. Dog Biscuits, W. B. Barnett, London.
7745. Dymamo-electric Machines, R. M. Baily, jun., and A. Grundy, London.
7746. Breaking, &c., Phosphate Stones, &c., T. Darling and J. Ford, Glasgow.
7747. Clothes Horse, G. R. Reed, London.
7748. Safety Attachment for Tram Engines and Cable Cars, G. T. Neville, London.
7749. Collapsible Lamp Shade Holder, W. Hardy, jun., London.
7750. Braces or Trouser Suspenders, A. E. G. Fryer, London.
7751. Electro-motors, F. Bailey, London.
7752. Station Gas Governors, W. C. Parkinson, London.
7753. Safety Automatic Lamp Extinguisher, M. J. March, London.
7754. Separating Solid Matter from Smoke, &c., E. Fleischer, London.
7755. Appliances for the Supply of Water, F. Brenner, London.
7756. Smoke Condensing Apparatus, H. H. Lake.—(*B. Roberts, United States.*)
7757. Construction of Walls, Ceilings, &c., C. Rabitz, London.
7758. Forming Slivers of Jute and other Fibres, H. H. Lake.—(*H. P. Garland, United States.*)
7759. Fastenings for Gloves, &c., J. F. Clasen, London.
7760. Beaters for Disintegrators, G. Little, London.
7761. Preparation of Oxides of Iron, E. A. and F. F. Jones, London.
7762. Spraying Liquids, F. F. Bourdil, London.
7763. End-on Motion with the Rotary Motion of Rollers used for Crushing Sugar Cane, W. H. Gilruth, London.
7764. Machine for Pruning, &c., Purposes, W. H. Gilruth, London.
7765. Eye Glasses, W. H. Gilruth, London.
7766. Spinal or Back-supporting Braces, M. Wilson, London.
7767. Window-sash Fastener, A. M. Clark.—(*W. R. Abrams, United States.*)
7768. Cutting, &c., Hay and Straw, W. Aylwin, Godalming.

28th May, 1887.

7769. Hanging Swing Looking Glasses, E. Sayers, Worthing.
7770. Oscillating Steam Engines, L. J. Wing and T. A. Richards, London.
7771. Gas Engines, E. G. Wastfield, Liverpool.
7772. Purifying Water, G. W. Allen, Manchester, and H. J. A. Bowers, London.
7773. Screw Fasteners, E. Salomons, Manchester, and F. Smith, Birmingham.
7774. Flushing Apparatus, G. A. Nussbaum, London.
7775. Securing Tubular Rivets, &c., G. F. Williamson and F. Litchfield, Wellingborough.
7776. Umbrella, &c., Spring and Holder, H. T. Munns, Birmingham.
7777. Pivot for Windows, &c., W. Phillips, Leeds.
7778. Facilitating the Escape of Persons from Buildings on Fire, H. J. Newcome, London.
7779. Roll Bars and Plates for Rag Engines, G. Hibbert, Gateshead.
7780. Cooking Ranges, J. E. Russell, Glasgow.
7781. Ventilating Carriages, T. P. Shelmerdine, Manchester.
7782. Feeding Oil, W. Defries and V. I. Feeny, London.
7783. Heels for Boots and Shoes, J. Watts, Manchester.
7784. Gas Fire for Circulating Hot Air, &c., A. Hill, Birmingham.
7785. Converter Bottoms, &c., G. A. Jarvis, Salop.
7786. Tramway Points, C. J. Nicholson, Birmingham.
7787. Fare Collecting Box, C. J. Nicholson, Birmingham.
7788. Picture Holders, D. Smith, Birmingham.
7789. Smokers' Cabinet, H. Bourne and R. W. Lomer, Birmingham.
7790. Photographic Apparatus, A. J. Boult.—(*H. S. Crocker, United States.*)
7791. Couplings, J. Bourne, Liverpool.
7792. Fire Extinguishers, J. and J. Hall, Manchester.
7793. Locking the Nuts of Fish-plate Bolts, C. Wheeler, jun., Lemington, near Newcastle-upon-Tyne.
7794. Castors, J. Hargreaves, Bradford.
7795. Flower Tube, F. W. Allchin, Northampton.
7796. Tension Devices for Loom Shuttles, J. Ireland, Dundee.
7797. Fastenings for Solitaires, &c., G. E. Walton, Birmingham.
7798. Operating the Cords of Window Blinds, &c., G. Whitehead, Birmingham.
7799. Sheep Shears, J. B. Meeson, Sheffield.
7800. Brake Block for Carriages, &c., W. Gooding, London.
7801. Treads for Stairs, &c., J. Munro, London.
7802. Ammeters, W. E. Ayrton and J. Perry, London.
7803. Raising, &., Roller Window Blinds, T. Turner, London.
7804. Venetian Blinds, T. Turner, London.
7805. Ironing Stoves, G. Goldsmith, London.
7806. Hauling in Fishing Nets, W. Killah, Glasgow.
7807. Claw Clamps for Boxes, J. Scherbel and T. Remus, London.
7808. Screws, &c., L. E. Sunter, London.
7809. Fireproofing Fluids, G. Harrison and O. Trimming, London.
7810. Auger Bits, C. H. Irwin, United States.
7811. Treating Tar for Heating Gas, W. Bäcker, London.
7812. Producing Mono-sulpho Acid, A. Liebmann and A. Studer, London.
7813. Filtering and Refining Sugar, F. Bosshardt. —(*G. Bocquet, France.*)
7814. Bricks and Bridges for Furnaces, E. Palmer, Sheffield.
7815. Steam Boilers, T. Taylor, London.
7816. Portable Ovens, G. Taddei, London.
7817. Automatically Discharging Water, J. Kroog, London.
7818. Commutators for Electric Generators, C. Coerper, London.
7819. Boot Protector, A. Savage, London.
7820. Needle Threading Thimble, R. Whitehead, London.
7821. Attachment of Rails to Sleepers, R. Haddan. —(*R. Vignoul, Belgium.*)
7822. Rope Lifts, M. T. Medway, London.
7823. Electrical Current to Vehicles, R. Laurence, London.
7824. Case and Locket Combined, E. A. Jahancke and H. W. Herbst, London.
7825. Sterilising Beer, W. T. Ramsden and L. Briant, London.
7826. Tea Packing Press, W. H. Gilruth, London.
7827. Withering Tea Leaf, W. H. Gilruth, London.
7828. Boiler Flues, G. H., A. L. Lloyd, and H. Bewlay, London.
7829. Steno-telegraphic Signals, W. H. Beck.—(*G. A. Cassagnes, France.*)
7830. Separating Solid Matters from Liquids, W. Macnab, sen. W. Macnab, jun., and J. Donald, London.
7831. Spun Rims for Smoke-consuming Reflectors, J. Taylor and F. Russell, London.
7832. Rings for Spinning, A. M. Clark.—(*J. J. Bourcart, Switzerland.*)
7833. Treatment of Naphthazarine, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
7834. Controlling, &c., Electric Currents, H. Edmunds, London.
7835. Boilers, &c., J. S. Fairfax, London.
7836. Wire-stitching Machines, C. L. Lasch, London.
7837. Checking, &c., Tickets, W. R. Oswald, London.
7838. Fire-bars, J. Woodgate and J. Simmons, Grays.
7839. Prevention of Guttering of Candles, F. B. Hanbury, London.
7840. Rotary Steam Engines, J. B. Pegden, London.
7841. Multiplying Plate Winch, H. H. Cordes, London.

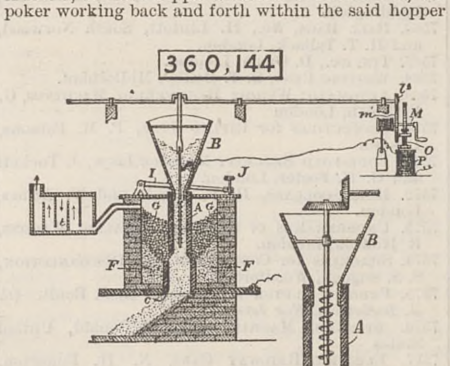
SELECTED AMERICAN PATENTS.

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

360,144. Electric Furnaces, *E. H. and A. H. Cowles, Cleveland, Ohio.—Filed October* 16*th*, 1885.

Claim.—(1) In an electric furnace, the combination of two stationary electrodes of opposite polarity, a body of material which is a bad conductor of heat and electricity surrounding the zone of fusion, a feed hopper for the charge to be reduced, and means for automatically moving the charge between the said electrodes when the normal resistance is diminished, substantially as and for the purpose set forth. (2) In an electric furnace, the combination of the electrodes A and C, the feed hopper attached to electrode A, the poker working back and forth within the said hopper

360,144

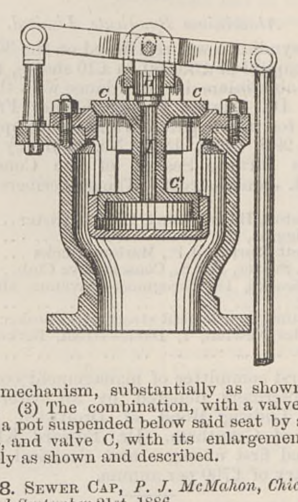


and electrode, the driving shaft provided with a crank for actuating the said poker and with the gear wheel l^2, the motor shaft M, provided with the means for rotating it, the gear-wheel m, and a brake wheel, the brake lever having the projection n^2, engaging with the brake wheel, the spring O, attached to the said brake lever at its free end, and the electro-magnet P, for disengaging the brake lever when the normal amount of current passing through the magnet is increased, substantially as and for the purpose set forth. (3) In an electric furnace, the combination of the retaining walls, the electrode C, the fine charcoal lining F, the electrode A, the feed hopper B, the lining of coarse charcoal G, the condenser t, the lever I, pivotted at the top of the furnace for supporting the said feed hopper and electrode A, and the screw J, for adjusting the position of the electrode A within the furnace, substantially as and for the purpose set forth.

360,171. Balanced Throttle Valve, *W. A. Pendry, Detroit, Mich.—Filed January* 11*th*, 1886.

Claim.—(1) The combination, with the shell of a valve, of a seat formed in or on said shell, a pot suspended below said seat, a valve adapted to close said seat, and extending through said seat into said pot, and having a passage therethrough, a valve stem adapted to close said passage through said valve, lifting mechanism connected with said stem, and a lost motion connection between said valve and the lifting mechanism whereby the action of the lifting mechanism will first raise said valve stem and then raise the valve, substantially as shown and described. (2) In combination with the valve C, having the passage I therethrough, the stem H, lifting mechanism connected with stem, and a lost motion connection between the upper end of valve C and the

360,171

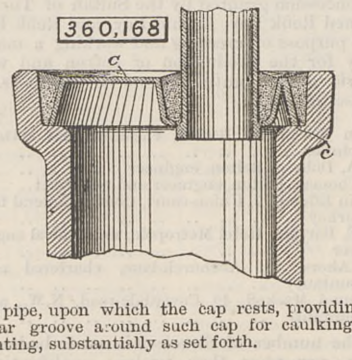


lifting mechanism, substantially as shown and described. (3) The combination, with a valve shell and seat, of a pot suspended below said seat by a skeleton support, and valve C, with its enlargement C′, substantially as shown and described.

360,168. Sewer Cap, *P. J. McMahon, Chicago, Ill.—Filed September* 21*st*, 1886.

Claim.—The metallic sewer cap C, having annular flange c, in combination with a sewer pipe having an enlarged socket that forms the shoulder on the inside

360,168

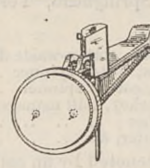


of the pipe, upon which the cap rests, providing an annular groove around such cap for caulking and cementing, substantially as set forth.

360,245. Hydrant, *T. Perkins, Springfield, Mass.—Filed September* 2*nd*, 1886.

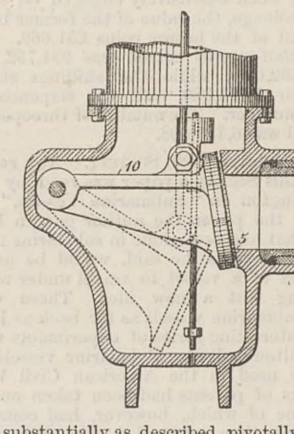
Claim.—A gate case for a hydrant, having the projecting gate seat 5 surrounding the inlet thereof, a gate 10, having a face on one end engaging with said seat and

360,245



pivotted by its opposite end on the inner side of said case opposite said inlet, and having a swinging motion downward away from said seat to open said inlet and upward to close it, combined with a gate operating

360,245

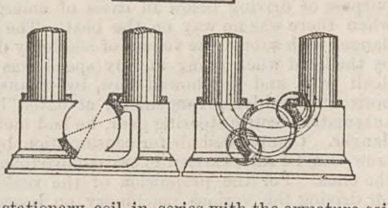


rod substantially as described, pivotally connected to the gate and extending upward into the hydrant case, substantially as set forth.

360,258. Dynamo-electric Machine, *H. E. Walter, Clifton, and C. Batchelor, New York.—Filed November, 6th,*1886.

Claim.—(1) The combination, with a dynamo-electric machine or electro-dynamic motor, of a stationary coil carried by the pole pieces of the field magnet in series with the armature coils, and wound outside the same at diagonally opposite points, and in such position that a magnetic circuit of said coil intersects the armature coils at the normal neutral line, whereby the self-induction in the armature coils is neutralised, substantially as set forth. (2) The combination, with a dynamo-electric machine or electro-dynamic motor,

360,258

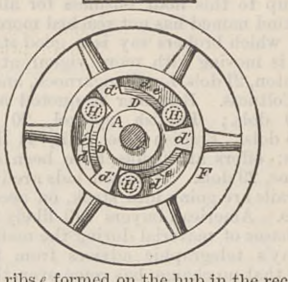


of a stationary coil in series with the armature coils and wound outside the same upon the poles of the field magnet at diagonally opposite points, and in such position that a magnetic circuit of said coil intersects the armature coils at the normal neutral line, and an extra differential coil upon the field magnet, also in series with the armature, substantially as set forth. (3) The combination, in a dynamo-electric machine, with the coil c, of the lips e on the field magnet, substantially as set forth.

360,262. Clutch, *C. Wehner, Buffalo, N.Y.—Filed November* 29*th*, 1886.

Claim.—(1) The combination, with the hub A, provided with cam-shaped ribs e, of a ring F surrounding the hub, and friction rollers H, arranged between the hub and the ring, and provided with grooves h, which engage over the ribs e, substantially as set forth. (2) The combination, with the hub A, provided on its face with recesses d, separated by projections d^1, and

360,262

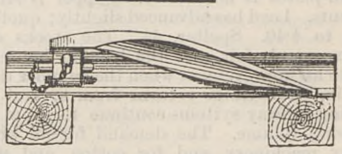


cam-shaped ribs e, formed on the hub in the recesses d, of a ring F surrounding the hub, and friction rollers H, arranged in the recesses d, and provided with grooves h, which engage over the ribs e, substantially as set forth

360,320. Car Replacer, *A. McLeod, Somerset, Ky.—Filed December* 27*th*, 1886.

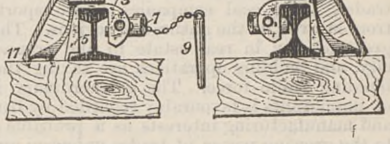
Claim.—The combination of the frog 15, having the rear spurs 17, and having the pivotted attachment 13

360,320



to a saddle 3, one of whose sides 5 bears against the base of the rail on the side nearest the frog, and the other of whose sides contains the locking jib 7 and

360,320

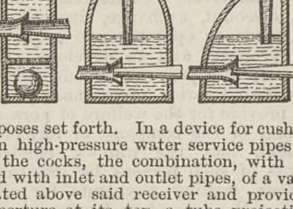


the key 9, substantially as and for the purposes set forth.

360,326. Device for Cushioning the Shock in Water Pipes by Automatic Cocks, *J. G. Richert, Gothenburg, Sweden.—Filed June* 11*th*, 1886.

Claim.—(1) In a device for cushioning the shock in high-pressure water service pipes caused by closing the cocks, the combination of a receiver provided with an inwardly opening valve, an outlet pipe having an outwardly flaring inner end, and an inlet pipe entering the flaring portion of said outlet pipe, as and for

360,326

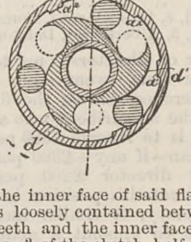


the purposes set forth. In a device for cushioning the shock in high-pressure water service pipes caused by closing the cocks, the combination, with a receiver provided with inlet and outlet pipes, of a valve chamber located above said receiver and provided with a valve aperture at its top, a tube projecting downwardly from said chamber, and a floating ball valve for closing said aperture, substantially as set forth.

360,393. Clutch, *T. Rogers, Springfield, Ohio.—Filed November* 23*rd*, 1886.

Claim.—The combination, in a clutch, of the clutch half C, secured to the shaft and having the radiating ratchet teeth d' formed upon its face, the loose clutch half A, having the annular flange a' formed upon its inner face, with a series of elongated projections a^2,

360,393

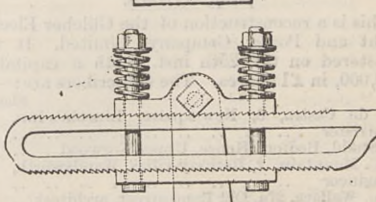


formed upon the inner face of said flange a', and the discs or rollers loosely contained between the acting faces of the teeth and the inner face of the flange a' and projections a^2 of the clutch half A, substantially as and for the purpose set forth.

360,400. Slack Adjuster for Car Brakes, *E. Corson, Brooklyn, and O. C. Crane, New York, N.Y.—Filed November* 8*th*, 1886.

Claim.—The combination, with the brake lever, of a brake rod having a forked end and teeth on the top and bottom edges thereof, clamping blocks above and below the fork engaging said teeth, and mortices for

360,400



the lever to pass through, a pivot connecting the lever to the lower clamping block, and bolts passing vertically through the clamping block and between the fork and springs around the bolts, substantially as set forth.