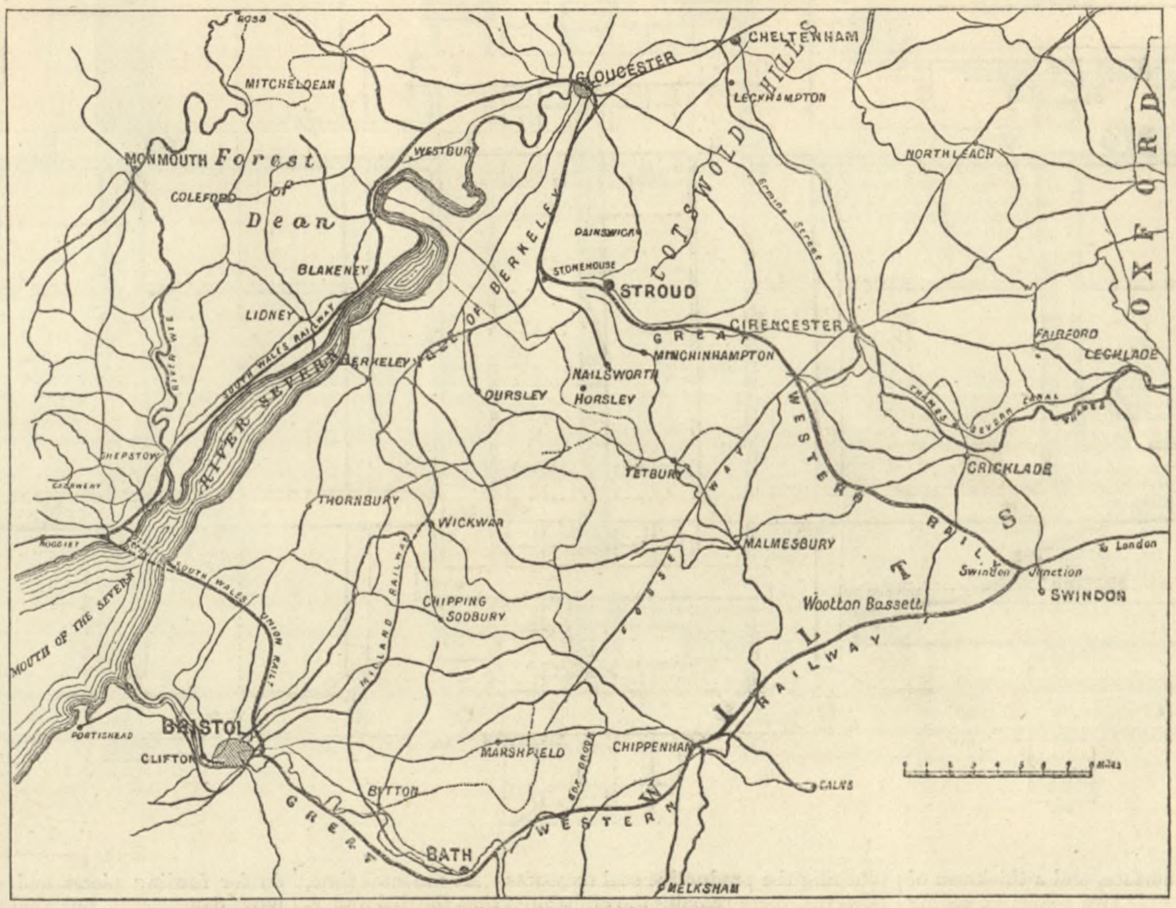
THE IRON AND STEEL INSTITUTE.

THE autumnal meeting of the Iron and Steel Institute is being held this year at Chester. It was intended that it should be held at Sheffield, but many of the leading steel-making firms refused to throw their works open, and Chester was then selected in some sense as a *pis aller*. Some misapprehension exists as to the policy pursued by Sheffield. The truth seems to be that the number of foreign members of the Institute being very large, some natural hesitation was shown by makers of special brands of steel about permitting what are, rightly or wrongly, regarded as trade secrets, being laid open, possibly, to the world. After all, the members of the Iron and Steel Institute have lost nothing. To a very great extent such meetings as the present are regarded and treated as special combinations of business with pleasure, and Chester and its environs supplies at once beautiful scenery, antiquarian interest, and enough manufacturing industry to satisfy very various tastes to the full. Thus, on Tuesday, after business was over, a really delightful excursion took place to Hawarden, the residence of Mr. Gladstone, and from thence to Eaton Hall, virtually a new palace built by the Duke of Westminster, where all that the most cultured, we may say the most scientific, art of the day can do has been done, without the smallest regard to the cost. On Wednesday again Crewe supplied entertainment of a different kind; there was, in short, no lack of attractions in Chester and its neighbourhood, and the Council may be congratulated on their selection. Nor is it to be forgotten that much, nay all that was enjoyable about the meeting was in the main due to the eminently courteous and hospitable fashion in which the good folk of Chester, from the Bishop, and Dean, and Mayor, down, received their visitors.



THE SEVERN TUNNEL RAILWAY AND CONNECTIONS.—(*For description see page 232.*)

Proceedings began in the Town Hall nominally at 10 a.m. on Tuesday. The Mayor, Alderman Charles Brown, briefly addressed the meeting, welcoming the Institute to Chester; he was followed by the very Rev. Dean Howson, who referred to the antiquarian interest which centres in Chester and its cathedral. To him succeeded the Lord Bishop of Chester, Dr. Stubbs, who echoed in great measure the Dean's welcome. The president, Sir B. Samuelson, delivered a very brief opening address. The minutes of the last meeting were then read, confirmed, and signed.

The President then said that it was now his duty to announce that, after considerable reflection as to what would best serve the interests of the Institute, the Council had determined, the previous night at their meeting, to depart somewhat from the rule which they had hitherto observed in nominating their president from amongst those gentlemen who were serving, or who had served on the Council, and that they had thought that it would be in the best interests of the Institute that some eminent man of science connected with the iron and steel industry, if such a man could be found, should be submitted to the members as their nominee for the presidency in succession to himself. They thought that no man could be found in this country, or perhaps in any country, who had rendered more conspicuous service to the progress of their industry than the gentleman whose name he was about to pronounce. It seemed to them also, from the advanced period of life in which that gentleman was, that unless the Institute could secure his services on the present occasion, they might not be able to do so hereafter. The gentleman, then, that the Council had recommended to the meeting for election as their next President, was Dr. Percy, Fellow of the Royal Society, who, as they were aware, had honoured the Institute as the Institute had honoured him, by accepting the Bessemer medal on a previous occasion. He had very great pleasure in submitting to them the name of Dr. Percy as their next President.

Mr. Isaac Lothian Bell, F.R.S., in a word, seconded the motion, and the recommendation of the Council was carried with acclamation.

The President then said it had not been customary at the country meetings of the Institute for the President to deliver an address, but he thought they would be glad to hear from him that the Institute was as prosperous as it ever had been, that the number of its members was being continually augmented, and that if, as he had every reason to suppose, those gentlemen who had been accepted by the Council as fit to become members on the previous night should be elected, the total membership of the Institute would be about 1400. They were glad to think that the Institute continued to be, as it had been almost from the beginning, an international Institute. The number of their foreign members he believed was increasing almost in the same ratio as that of their English members, and he also believed that their "Transactions" were as much consulted abroad as in former times. The list of papers which the Council had accepted and submitted to the Institute to be read and discussed, he thought, were also a great proof of the vitality of the Institute. He might also say that on no previous occasion had those papers been of greater interest than at the present time. They took a very wide range of subjects, all of which were of the greatest importance to the prosperity of their craft. If the financial prospects of their industry at this moment were not very brilliant, he believed that he might repeat what he said on the occasion of their meeting in Middlesbrough, that their depression was only statistical. He believed they were as full of vigour and hope as ever. Although production might for a time in all the countries of the world—for they were all suffering equally—have outrun the demand, that excess was only temporary, and, unlike the case of some other materials, the production in this would tend to stimulate consumption, and in future, as it had been in the past, the iron manufacturers would prove the benefactors of mankind.

A paper was then read by Mr. Aubrey Strahan, M.A., F.G.S.,—

ON THE GEOLOGY OF CHESHIRE.

This paper possesses little more than a local geological interest, except on certain points which are not eminently interesting to any one but geologists in general. Consequently we do not reproduce it in full. The most noteworthy portions are those dealing with the rock salt deposits of Cheshire.

The rock salt occurs in two beds, known as the top rock and the bottom rock respectively. They have been recently very fully described by Mr. T. Ward, of Northwich, from one of whose papers* the following is extracted:—"These two beds are separated by a layer of marl much indurated and containing veins of salt running nearly vertically, as if occupying rifts, or cracks, or crevices in the hardened marl. This layer is about 30ft. thick. The first bed of rock salt, or the 'top rock,' is at Northwich from 40 to 80 yards from the surface, varying with the different surface levels, and dipping from N.E to S.W. The surface of this bed is very irregular, being waterworn and channelled as if by minature streams. In most cases, immediately before reaching the salt, a much indurated marl is found, locally termed 'flag.' On piercing this flag, brine was met with in the first instance, and continues so to be to the present day." The top rock is about 25 yards and the bottom rock about 35 yards thick at Northwich; both are rather thicker at Winsford. The top rock salt is stated by Mr. Ward to have been discovered in 1670, and to have been largely worked after the river Weaver was made navigable in 1721. In 1781 the bottom rock salt was discovered, and was worked in preference to the top rock, the quality being better. The top mines were abandoned after the commencement of the present century, and have with one exception collapsed through the breaking in of water. Their positions are indicated by large funnel-shaped pits filled with water, locally known as "rock-pit" holes. In the upper mines large pillars about five yards square were left to support the roof. In the lower mines the pillars are now left from eight to twelve yards square, but one or two have collapsed, and others have been abandoned from the breaking in of water. Many have been allowed to fill with brine, which is pumped out for the manufacture of white salt. Though about 150,000 tons of rock salt are mined yearly from the bottom rock, this is not one-tenth of the quantity of white salt made from brine, the total quantity of which in 1880 reached 1,800,000 tons. The brine, which is found naturally on the surface of the top rock only, is reached by the sinking of a shaft or a well, cylindered to keep out the fresh water. As soon as the "flag" overlying the rock head is pierced, the brine rises in the shaft, but not nearly to the same extent as formerly. In other cases it is pumped from the abandoned mines in the bottom rock. It is then distributed in pipes to wrought iron pans, where it is kept heated to a temperature varying from 90 deg. to 180 deg. Fah., according to the quality of the salt required. As the water evaporates the salt crystallises out, and is removed from time to time. As a result of the removal of this vast amount of material, there have ensued the most disastrous surface disturbances. While the breaking in of the old rock pits has formed funnel shaped abysses from 50 to 150 yards across, the continual abstraction of brine, and presumably of the upper part of the top rock in solution, has led to the subsidence of broad tracts of land, and their consequent flooding by river water. The broad shallow lakes thus formed are known as "flashes;" one at Northwich occupies a space of about 100 acres. The movements result also in the destruction of buildings, and alterations in the levels of drains, canals, and railways. In consequence of the great destruction of their property, the owners applied to Parliament in 1881 to obtain a bill called "The Cheshire Salt Districts Compensation Bill." In the evidence given before a Parliamentary Committee, it was stated that the area of land affected amounted to 2808 acres, and the value of the property, exclusive of railways and canals, was given at £480,000, the amount of depreciation being estimated at £168,500. The object was to obtain compensation for the damage by means of a contribution of a sum not exceeding threepence for every ton of salt in brine raised in the district. The attempt, however, was unsuccessful. A large amount of evidence was brought forward in the course of the proceedings. By the promoters of the bill it was contended that the subsidence was due to the abstraction of the brine by pumping, natural causes producing no perceptible damage. It was pointed out that the rate and extent of the movement has increased with the growth of the salt manufacture. By the opposers it was urged that the subsidence of the ground, in Winsford especially, was due originally to natural causes, viz., the absorption of a portion of the rainfall, and subsequent escape of this water in the shape of brine springs. It was sought to prove that the rivers had been more salty in former days than now, when so much is raised by the pumps. The subsidences at Northwich were attributed largely to bad mining in former days. Importance was attached also to the Cheshire meres, as indicating the site of old subsidences naturally produced. It is mentioned here that a large number of these meres have been wrongly attributed to this cause. Those of Delamere Forest, for example, exceeding sixty in number, are shallow basins in drift sand, a deposit which is characterised by its tendency to form such basins in all parts of the country, irrespective of what rock it rests on. Ellesmere is a shallow mere in the sand, in the bunter sandstone area, in which rock-salt does not occur. A review of the evidence given before the Committee seems to show that while the theory that natural causes were adequate to produce the results, involved a great deal of pure speculation, the facts went to prove a direct connection between the amount of pumping and of the surface disturbance.* The rock-salt beds lie nearly horizontally, more nearly so than the lower beds of the keuper, which crop out near the margin of the basin. So far as is known at present they occur as lenticular beds in the marls, thinning away in all directions from an area of greatest development; but whether this is the original form of deposition, or the result of the dissolving away of the salt near its outcrop, is not clearly proved. From analogy with what takes place in salt lakes at the present day, it appears more likely to have been formed in patches in the deeper or quiet parts of the water. On the latter theory, the salt should be found under all the deeper parts of the Cheshire basin, including the area overlaid by the lias outlier.

After dealing at considerable length with the geological formation of the deposit and the value of the stones as building material, the author turned to the coal possibilities of the district. No experiments have been made, he said, up to the present to ascertain the nature of the rocks underlying the trias of Cheshire. In Lancashire the coal measures have been reached by sinking through the bunter sandstone close to its margin; but the deepest boring at present made at any distance away from this margin—namely, at Bootle, near Liverpool—merely resulted in proving an unexpected thickness of pebble beds. The Lancashire colliery sinkings and borings for water show that in the western part there is either no permian intervening between the bunter and the coal measures, or that it is extremely thin; but it has also been proved that the productive coal measures are overlaid by an enormous mass of measures in which no seam of any value occurs. At the Bold Hall Colliery, for example, after traversing 186ft. of new red sandstone, the shaft entered unproductive measures, which continued for a distance of 1178ft. before the first coal of any value—the Lyons Delf—was reached. At the Collins Green Colliery the coal measures

* Memoirs of Manchester Lit. and Phil. Soc., Session 1881-82

* This subject has been treated very fully by Mr. Ward in a pamphlet entitled "Notes on the Cheshire Salt Districts Compensation Bill," Northwich, 1881.

FOUR-WHEEL BOGIES OF AMERICAN PALACE CAR.

(*For description see page 193.*)

FIG. 21.

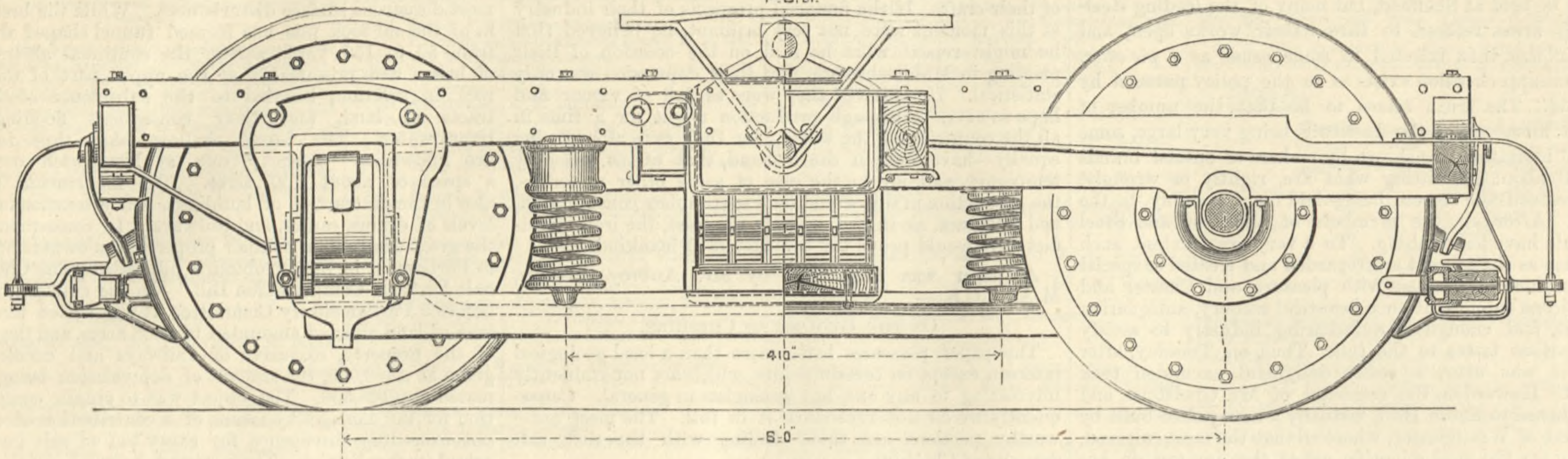
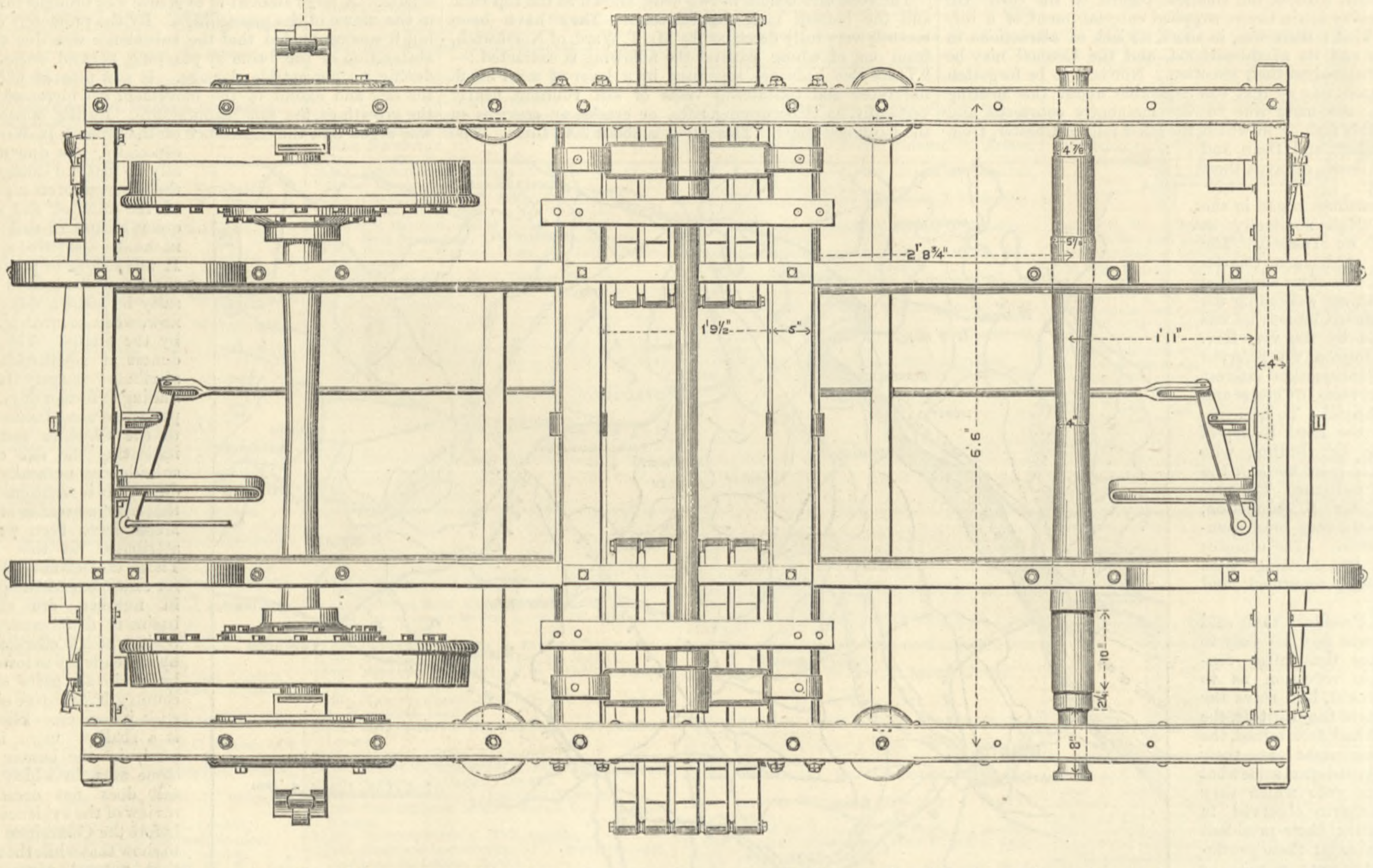


FIG. 22.



were entered at 310ft. from the surface, and a thickness of 1103ft. of measures, containing only two seams exceeding 1ft. in thickness, and none reaching 18in., was penetrated before reaching the top seams of the Wigan coalfield. The dip of the coal measures is, generally speaking, towards the south, in the same direction as that of the trias, but at a more rapid rate. There would, therefore, be a greater thickness of measures to traverse, in addition to the increased thickness of trias, than might be expected at any point farther south. Against this it may be stated that this mass of unproductive measures is found in the Manchester district to be overlaid by the Bradford and Clayton series, in which seven seams of coal occur. There should, therefore, be a possibility of proving this series by sinking farther to the south, so as to get into the beds overlying the unproductive parts at present proved. It is, however, very problematical whether these seams exist in a workable form in West Lancashire. The whole series of coal measures undergoes a rapid attenuation in a westerly or south-westerly direction after passing Wigan, and the seams themselves deteriorate in the same direction, with a tendency to become thinner. Allowing for the thinning-out of the measures, it would seem that the upper series of seams should have been found at the collieries above mentioned at a less distance than 1178ft. above the Lyons Delf, if they exist. Farther to the east, in the neighbourhood of Manchester, the coal measures are overlaid by permian rocks consisting of marls and a lower subdivision of soft red sandstone resembling lower bunter. The coal measures themselves are divided into an upper and middle series by the great mass of unproductive measures before alluded to, which approach 2000ft. in thickness, and have at present defeated any attempt to prove the upper and middle coal measures in a single shaft. Having regard to the neighbouring portion of the Cheshire basin, it would therefore seem that, after penetrating the trias, an unknown thickness of permian would be encountered, the lower part of which would probably be water-logged and troublesome to pass, and that the result would probably be the proving of the upper coal measures only of the Manchester field. This brief review of the rocks of the Cheshire basin would seem to show that a very great mass of rock, part of it of a very unsuitable nature for the sinking of a shaft, would have to be traversed in almost any part of the triassic area before touching the productive coal measures. At the same time, however, there remains the probability that the coal underlies the greater part of the area. It becomes, then, a question of engineering, and of the comparative value of the coal and expense of getting it. The Coal Commission estimated the thickness of the permian at 1500ft., that of the bunter sandstone at 1300ft., and that of the new red marl at 2000ft., or a total of at least 4800ft. Taking into consideration the costliness of sinking with our present machinery, the outlay would not, in my opinion, be repaid. The financial success attending the working of the known coal-fields on the west side at least of the Cheshire basin has not been such as to encourage costly explorations in unknown ground.

Professor Hughes, of Cambridge, said a few words on the paper, alluding to the theory that hematite was simply red ore washed out of the sandstone into lower measures. In Cheshire, although there was plenty of distributed hematite, it was not in a form available for use. After a few words from Mr. Snelus and the President, a vote of thanks was passed, and Mr. Henry Seebohm read a paper on the manufacture of crucible steel, the first portion of which paper will be found on page 236. In every respect this was an admirable contribution to the literature of steel. It was read with considerable emphasis and force by the author, and its best bits evoked much laughter. Mr. Seebohm sat down amid a perfect storm of applause. The paper is, indeed, a perfect monograph on pot steel, and leaves little or nothing to be added.

The discussion was opened by the President, who read a letter from Sir H. Bessemer, who regretted that he could not be present, as he understood that Mr. Seebohm was going to "have an elastic kick at Bessemer steel." He—Sir Henry—added that about one-half the crucible steel now made is of Bessemer bars, and he proposed on a future occasion to read a paper on the subject himself. Mr. D. Adamson said that he had often felt confounded by the results of his experience with pot steel, but he never was so confounded as now, after hearing Mr. Seebohm's paper. The chemist must slip in to help them. The great want now was a really first-class steel that would temper at a low heat, and which would not distort in the process. He would rather pay 2s. a pound for good than 6d. a pound for second-rate steel. He was glad to add that he saw some prospect of getting a steel which would do for fowling pieces and cannon, because it would not burst dangerously, but would give warning before it failed. After a few words by one or two other speakers, Mr. Snelus said that science must come in to give us the finest steel in the world. He was quite prepared to agree with one of the speakers who had preceded him, and admit that manganese might exist in steel under two forms, just as carbon might; and he then referred to some experiments of his on steel pounded to a fine powder, which tended to prove this thesis. He found that carbon manganese and sulphur all behaved in much the same way in this respect, but silicon was an exception. The reason why hematite iron was so good was that it had very little phosphorus in it—not more than 0·03 per cent.; and he said it was strange that no one had endeavoured to produce a pot steel without any phosphorus, which might be done by a modification of the basic process. A very small difference in the percentage of phosphorus made a great difference in the quality of pot steel. Thus Danamora iron had only 0·02 per cent., and it was much better than hematite. Mr. Riley followed to the same effect, saying he had found the difference in result obtained with steel bullets to be very great, the steel of which one lot were made having 0·104 per cent., while the other had 0·102 per cent. of phosphorus. Small as this seemed, one lot was brittle and the other sound.

After a few words from Mr. Nursey, the discussion was adjourned to Wednesday morning, and the Mayor entertained the party at luncheon. At two o'clock nearly 300 members and their friends proceeded in drags and carriages to Hawarden, and subsequently to Eaton Hall. In the evening the annual dinner took place at the Grosvenor Hotel.

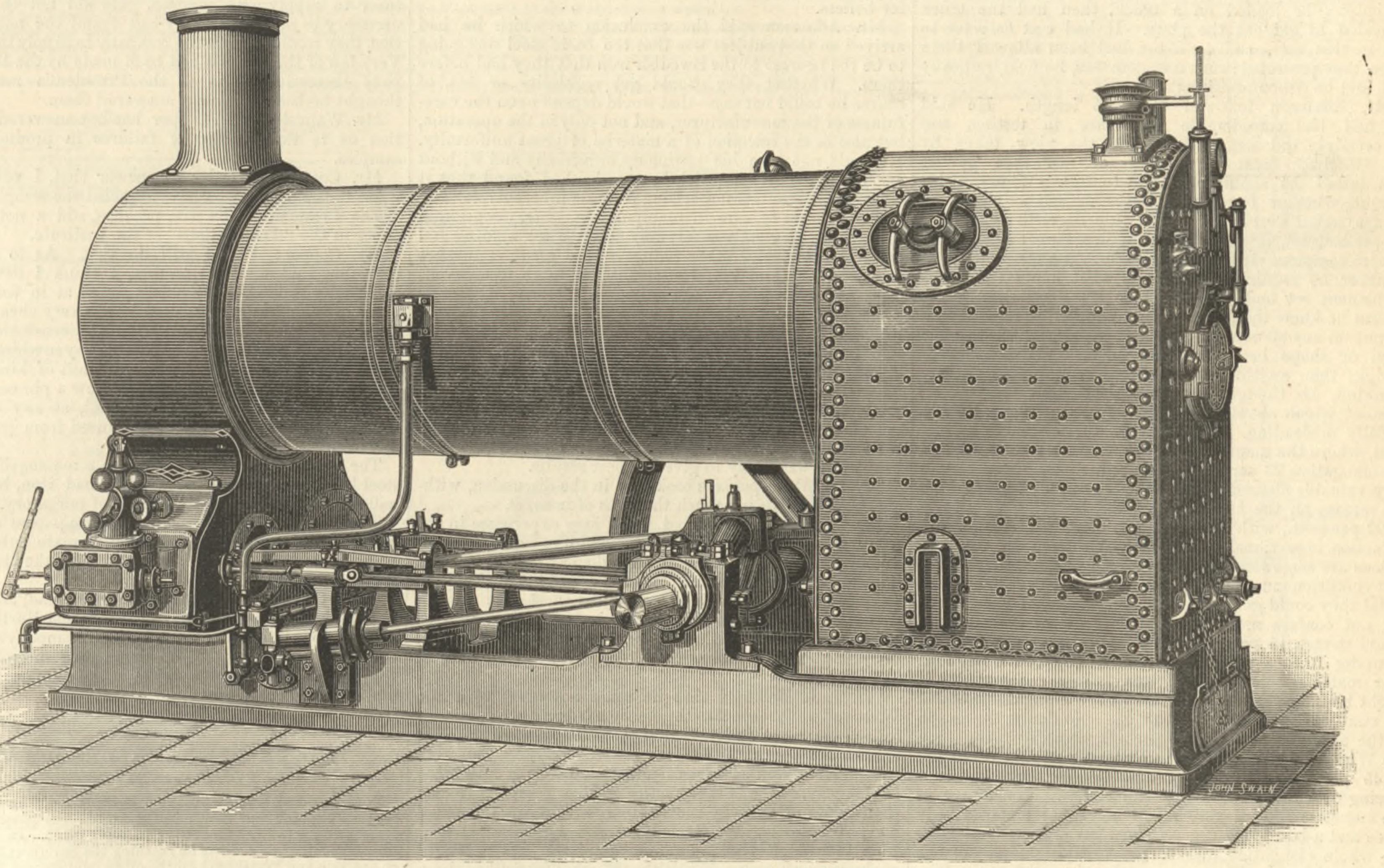
On Wednesday morning the discussion on Mr. Seebohm's paper was resumed, Mr. Hall, of Sheffield, being the first speaker. He defended the action taken by Sheffield, and denied that it was lack of hospitality that had prevented them from inviting the Iron and Steel Institute to their city. Rather it was that the Iron and Steel Institute regarded Sheffield grit steel as something effete, and the industry of the town too antiquated to be worth looking after. As regarded Sir Henry Bessemer, he begged to assure him that there was nothing antagonistic between his process and Sheffield, but the reverse, because the substitution of steel for iron in tires and such like had rendered more than ever necessary the use of a first-class steel for tools. More pot steel was made during the last three years than ever was made in Sheffield before, his own firm alone converting no less than 18,000 tons of Swedish iron, worth from £12 to £28 per ton, into steel which represented more than one million pounds worth of tools. Melted Bessemer steel could be had very cheap; but the engineers who believed that such stuff was equal to the best pot steel were fools. He concluded with a graceful tribute to Mr. T. Jessop, a father of the Sheffield steel industry, and now over eighty years old.

Mr. Lothian Bell said that he had found manganese behave in much the same way as carbon. He had analysed some stuff which he had found on the outside of pigs. It turned out that this was silica, which had been extruded in some way as silicon, and was subsequently oxidised into silica. The chemists had been too short a time at work at iron and steel to do all that might be expected, but they were getting on. Thus he had some iron sent him from Monkbridge which was red-short. He had it tested for oxygen, but found at first no more than was in iron not red-short. By a new method of testing, however, it was found that the red-short iron contained about twice as much oxygen as the other. Mr. Seebohm then replied briefly and appropriately, and a vote of thanks having been passed by acclamation, a paper was read by Mr. Cooper,

ON THE NORTH-EASTERN STEEL COMPANY'S WORKS AND THEIR PRODUCTS.

This paper dealt very largely with the value of steel as a constructive material, going over a good deal of well traversed ground, and opening up some questions which, it was believed by some people, had long been set at rest.

The erection of the North-Eastern Steel Company's Works was commenced in November, 1881, and was completed in June, 1883. The works are situated on the south bank of the river Tees, in what is generally known as the ironmaking district, and they have access to several groups of blast furnaces, from all of which supplies of metal in its molten state can be readily obtained. They were specially designed to suit the requirements of the Thomas-Gilchrist or basic process, for the manufacture of steel from Cleveland and other phosphoric irons; and although they are equally well adapted for the manufacture of hematite steel, up to the present time no other steel than basic has been produced. The Bessemer converting plant consists of four 10-ton converters, placed in a line in a staging 22ft. above ground level, each converter shell or casing, made in three sections, being removable from the trunnion ring, after the manner patented by the late Mr. Holley. At one end of the line of converters stand three cupolas for melting pig iron, each cupola capable of melting 1600 to 1700 tons of iron per week. These cupolas have their tapping holes arranged about 6ft. above the ground line. The pig iron after being melted is tapped out into a ladle fixed in a four-wheeled carriage; the ladle is afterwards lifted by means of a 20-ton hydraulic lift—placed between the cupolas and converters—to the level of the converter stage; it is then moved by a small locomotive to the front of the converter and its contents tipped in. A second 20-ton lift is placed at the extreme end of the cupola stage, by which entire trucks of pig iron and coke may be raised for charging direct into the cupolas, the general disposition of the two lifts being such that either may be used for all purposes for which each is specially designed. The converter stage and that from which the pig iron cupolas are charged are on one level, so that one locomotive does the whole of the shunting, both of pig iron, coke, molten iron, and spiegel, and the cupolas for melting this latter metal are so arranged that they deliver their charges into ladles running on the same stage, which ladles can be moved direct from the cupolas to the converters. The charging of the spiegel cupolas is conducted from a stage 12ft. higher, from which level the lime taken up in light wrought iron bogies is discharged into the several converters by means of shoots communicating with each. The spiegel lime and ferro-manganese are lifted by means of two 2-ton hydraulic hoists, at the foot of which are placed the stocks of these materials. Immediately behind the converters is placed the lining and bottom shop, in which the whole of the lining and bottom-making is conducted; behind this again are the crushers and mills for crushing and mixing the basic material used for the converter linings; and at one end of the line of crushing machinery stand the cupolas in which the basic material is prepared. The magnesian limestone, or dolomite, from which this material is produced, is charged into the cupolas with coke, and after being thoroughly shrunk is drawn off from the bottom about every two hours, and when cool is picked over by hand, that which is insufficiently calcined being put back into the cupola, while that which is sufficiently shrunk is carried up to a stage running over the crushers, from which, as required, it is fed into the grinding machinery, and mixed with about 10 per cent. of boiled tar, to give it the cohesion necessary for the manufacture of the bricks and linings. The bricks, which are used exclusively for lining up the body section or middle portion of the converters, are made by ramming the mixture into wrought iron boxes or moulds with hot rammers. Lids or covers are then secured over the moulds. The bricks, thus encased in iron, are placed in ovens and coked for about ten hours, after which they are taken from the moulds and are ready for use, having become exceedingly hard and dense under the operation. The plugs, or bottoms, are rammed of the basic material in a similar way, steel pins being inserted to form the perforations for the blast, while the bottoms are encased in iron, as the bricks are coked in specially-designed stoves, this operation taking about a week; the iron casings being removed and the pins knocked out, the bottoms are fit for use. The bottom section of the converters and the nose section are likewise rammed with the basic mixture, cast iron moulds being placed inside the casings for this purpose. The coking is effected by making fires inside the moulds themselves. The method of changing the converter shell is as follows:—As soon as the lining has worn too thin, which is usually the case after it has produced from 500 to 600 tons of steel, the bottom section, containing the plug or bottom, is taken off by means of a hydraulic ram fixed on a carriage, running underneath the converters, on lines of rails communicating with the lining shop, into which it is quickly drawn by means of a wire rope and a steam winch. The nose section is dealt with in a similar manner. The body portion, or middle section, is afterwards lowered from the trunnion ring by means of an overhead 60-ton steam travelling crane, placed on a carriage, and taken to the lining shop in the same way. A 30-ton steam travelling crane, running the whole length of the lining and bottom shop, removes these worn-out sections from the carriages and replaces them with newly-lined ones, of which several are always kept in readiness. The new sections are put together with the same appliances, commencing with the body section, which is first lifted into the trunnion ring by means of the 60-ton crane; the joints of the various sections are made with a mixture of the material containing a larger amount of tar, so as to make it quite plastic. On the front side, and between each pair of converters, is fixed a ladle crane, by means of which the ladle of finished steel is transferred from the converters to a large casting crane placed in a 60ft. diameter pit, in front of and between the transfer cranes, and in such a position that it may receive the steel from each. The casting pit is commanded by four ingot cranes for fixing the moulds and dealing with the ingots. On one side of the casting shop stands the engine-house, containing two pairs of vertical blowing engines with steam cylinders 40in. diameter, air cylinders 54in. diameter, and a stroke of 5ft.; two pairs of hydraulic pumping engines, each having a pair of 26in. diameter steam cylinders, and four hydraulic cylinders 6in. diameter with a stroke of 3ft.; three blowers for melting pig iron, each having a capacity of 60 cubic feet per revolution; three pairs of boiler feed pumps; and two accumulators, each having 24in. diameter cylinders and a stroke of 15ft. In front of the casting pit is the cogging mill, with an arrangement of Gjers' soaking pits on the right-hand side, and heating furnaces on the left. The cogging mill consists of a pair of rolls 36in. diameter, driven by a pair of geared reversing engines with 40in. diameter steam cylinders and 60in. stroke. In this mill ingots are rolled down into slabs for plates and sheets, and into blooms. These slabs or blooms, after being sheared by a powerful shearing machine, are either carried off to the side of the mill for loading up, or they are taken forward whilst still hot, by means of a train of live rollers, to the finishing or rail mill, to be still further reduced. The finishing mill consists of two pairs of 28in. rolls, driven by a pair of direct-acting reversing engines with steam cylinders 50in. diameter and 54in. stroke. In these rolls the blooms are reduced to rails, billets, small slabs, bars, &c., of any section, and are then carried forward to the cutting machinery, and finished in the usual way. By the side of the mill are fixed fifteen double-flued boilers, each 28ft. long and 7ft. diameter, working at a pressure of 90lb. per square inch. Two of the heating furnaces have each a boiler attached to them of the horizontal type. The steam from the hydraulic pumping engines, blowers, and feed pumps is passed through a large water heater, which heats the feed-water on its way to the boilers to a temperature of about 180 deg. Fah.



COMPOUND SEMI-FIXED ENGINE, CONSTRUCTED BY MESSRS. ROBEY AND CO.—*(For description see page 241.)*

A large number of samples of basic steel in various forms was exhibited, such as deck iron, Galloway tubes, &c. With reference to the ordinary soft quality now being used for sleepers, tin-plates, stamping sheets, and wire, in order to determine the maximum and minimum limits of strength between which this material could be regularly produced at the cheapest cost, on August 23rd a sample bloom was taken from twelve consecutive blows, which had been made in the ordinary course the day before for tin-plates. These blooms were rolled down into plates $\frac{1}{32}$in. thick, and strips were taken from each plate and tested for tensile strength, with the following results:—

Blow No.	Breaking strain.	Elongation. Per cent.	Reduction of area. Per cent.
835	26·86	29	52·4
836	28·34	23	55·3
837	26·70	28	49·7
838	26·20	30	55·4
839	26·86	28	48·2
840	23·53	28	57·0
841	25·94	29	54·6
842	27·53	26	51·9
843	27·28	28	51·0
844	23·92	29	59·3
845	25·32	26	54·5
846	27·99	28	45·9

These results show that the tensile strength ranges between

23·53 tons and 28·34 tons, and the elongation between 23 per cent. and 30 per cent. Strips from each blow were also submitted to the quenching tests as applied by Lloyds', and all stood. The whole of these test pieces were produced for inspection. From the above figures the author held that it is quite certain that by the basic process a low steel or ingot iron can be produced regularly, having a tensile strength which would not fall below 23 tons or rise above 31 tons at the very outside, with an elongation of 20 per cent. and upwards. It is likewise quite certain that this material could be made at a very much lower cost than the 27 to 31-ton steel used at the present time for shipbuilding, as with the range of 8 tons there would be no necessity for the steel maker to concern himself about tests during the process, the pig being taken from the blast furnaces molten, the ingots hot from the casting pit, and as far as practicable rolled straight off into the finished product, as in the case of rails, saving heat, waste, time, and labour, amounting in all to a very considerable item per ton on the finished plate or angle.

The discussion was commenced by Mr. Snelus, who denounced the present system of testing as iniquitous, putting, as it did, steel makers to an expense of from 5s. to 7s. a ton. He held that testing should not be done away with, but excessive and unnecessary testing. He held that it would suffice if strips from the plate were bent cold to a right angle, and that anything more was, for strip plates at all events, quite needless. He was followed by Mr. Riley, of Glasgow, who entirely differed from Mr. Snelus, and held that there could scarcely be too much testing. Mr. Snelus begged to be allowed to explain that he was not opposed to testing, but Lloyd's people let the plates be loaded on a truck, then had the truck unloaded to get out the plate. It had cost 8s. a ton to test in this way, and 4s. a ton had been allowed them when they protested; such a system was, he held, radically bad, and he denounced it as such.

Mr. Adamson followed at great length. He said he had had considerable experience in testing, and he certainly did not quite follow the view taken by Mr. Snelus, because whether or not that gentleman tested, he should continue to test. Wherever he bought, whether from Mr. Snelus or anybody else, he always tested every plate. He only regretted that Mr. Cooper had not, in his table on the breaking strain, given a more complete view of the subject. As a manufacturing engineer, he required to know at what amount of stress permanent set took place in these low ductile materials. Unless he knew that, he could not know what force should be put on any structure; and, as this material was in some form or shape better adapted for the manufacture of bridges than anything else that had been brought before mankind, he thought that the permanent set was an element which should never be left out. The table was awfully misleading. For example, there was the section steel, where the manufacturing strain was 28·34 tons, and the elongation 23 per cent. The reduction of area—not a very valuable element—was 55·3 per cent. Then, taking the reverse on the last but two, the breaking strain was 23·92 per cent., with an elongation of 29 per cent., and a reduction in sectional area of 59. Although the two conditions are somewhat different, it led him to think that the first condition must be its permanent set. Take the purest metal they could get hold of in the shape of iron, which did not contain more than 2 per cent. of alloy, and it would stretch 45 per cent.; it would take a permanent set of under 10 tons per square inch. You could not load that material more than 5 tons, however defendable it might be. The reduction of area after elongation was, in his mind, a very unimportant thing. No doubt, the length of the specimen was very important, because if you took the Woolwich test of 2in., the elongation would often get to 45 per cent., the break and the elongation always passing over three and a-half times the sectional area of the metal, so that if you had a length of material only three and a-half times the sectional area, you would have the whole elongation due to the breaking strain of the maximum load. That was only one element. The reduction of area was the result of the termination of the test, and if you tested with a lever, and without any means of checking its descent, the moment you had arrived at the full test, down went the lever and the specimen was broken, and you only had the breaking sectional area. With the more refined and dependable test you had the permanent set, and how it elongated as it got slightly punished with the increased load. Its power of endurance slowly increased until the maximum force was attained, and then it ceased to carry the load any further. Now he only regretted that he was not in a position to give them a tabulated statement, showing that as the sectional area decreased by the breaking elongation, the load-carrying power diminished as it went forward, so that by checking the full consequence of the death, so to speak, of the material after its full power had been carried, they wanted to compare the sectional area, for it always showed the largest amount of diminution of area at the weak point where rupture ultimately took place. But rupture did not take place sufficiently real not to be of some great importance to register the conditions of its development. For instance, take this maximum load of the section test of 23 tons. The general law of permanent set followed a close approximation upon half the total weight-carrying power of the material, so that 23 or 24 tons would not show permanent set until it got a load of about 12 tons upon it. If he wanted to select a material to carry a tensile load in a bridge, he should go hard upon 60 tons per square inch for the tensile strain. With 60 tons you could get generally an elongation equal to Lowmoor plate. With this material, then, for bridge purposes you could get no permanent set until you got about 28 tons. Now, 28 tons was positively more than this material carried to begin with, showing the importance of tracing the whole operation from beginning to end if you were to take advantage of the value of the material you were going to use. He hardly thought he need say more on that point. He advocated that instead of giving the technical sectional area they should give what he might call the dying effort. He spoke more especially of the section of an inch, an inch being the universal test. He had some season to speak from experience, as he had carried out many hundreds of tests for the purposes of which Mr. Riley had spoken; and if the manufacturer did not test, he would. If we could get a diminished area on a sectional inch recorded in its diminution at every ton, we could tell also, after the maximum load had been carried, how far it might elongate before it became dangerous to use it at half the strain that would produce permanent set; afer that destruction would ensue. They were apt to put just so much strain upon a material that it would never bear the like again. Was it of little importance that they lost two eminent men at Sheffield by the breaking of a crank axle? and further than this, it had been stated throughout the country that during the first three months of the year there were nearly 100 crank axles broken. Did it therefore appear that they were so exceedingly particular in testing? Instead of relaxing testing in cases where human life might depend upon the stability of the material, he thought that tests ought to be increased, so that with an elaborate system of tests and careful analysis they might get crank axles that would not break. In his opinion, the country had a right to look to this Institute to give such attention to these questions as would secure the public safety. The engineer of a railway company should be less of a manufacturer, and should carry his people safe and well. The result would be infinitely more satisfactory to the public. The more minds that could be brought to bear on this question the better.

The President observed that perhaps Mr. Adamson would give them his experience of the use of basic plates for boilers.

Mr. Adamson said the conclusion to which he had arrived on that subject was that the basic steel was going to be the nearest to the Swedish iron that they had before them. Whether they should get regularity or not, of course he could not say—that would depend upon the carefulness of the manufacturer, and not only in the operation, but also in the selection of a material of great uniformity. He could not give his testimony universally and without exception to the material, because he had found that it had some infirmities not arising from its inherent qualities, but from want of care in manipulation. Mr. Cooper told them that this steel was not only suitable for welding and chain making, and other things where great endurance was necessary, and would supplant the more treacherous iron; and while you got not only a higher carrying power, you would get much more ductile and elongating power, which he thought was in all cases more or less the measure of its dependability in practice. In the drift passing through the weld the report was exemplary, the only condition not named being the taper of the drift. He had conducted many experiments in drifting, and knew that the element of time was not unimportant—not bringing the strain on the material too quickly. The drift with the least taper was likely to give the best results.

Several other speakers took part in the discussion, without, however, adding much that was of interest.

Mr. Walmsley said he had had a long experience in the iron trade, and he had lived long enough to know that producing a number of samples for a display on an occasion like this was one thing, and that the average make from week to week and month to month was another thing. He should be very glad if Mr. Cooper, in his reply, would be good enough to say that in producing these admirable samples that were before them how many spoiled ones he had made.

Mr. I. L. Bell said that he could not agree with Mr. Whitwell with respect to the steel made by the basic process for any purposes, except that of rails. But it might interest them to know that the North-Eastern Railway Company had now received at least fifty thousand tons of rails made in this way. It was the practice of that company to test their rails not only by the hauling weight, in the usual way, but also by actual analysis, and he supposed they passed through the laboratory at least five hundred analyses every year. While the North-Eastern had been receiving basic rails, they had also received acid rails, and he was bound to say whatever the amount of regularity might be as attending the one was equally conspicuous in the other. There was, in point of fact, no difference, and he happened to have by him the figures, of an average character. He would just, if they would allow him, read it out to the meeting. In carbon, the average analysis of both was ·45 per cent.; of silicon in the hematite—that was, acid—it was ·105 for the hematite, and ·06 for the basic, so that there was about half the silicon in the basic rail that there was in the acid. Of sulphur, in the hematite, ·121, and in the basic, ·095. The phosphorus was precisely the same in each—·05. The manganese was 1·17 in the hematite and 1·20 in the basic. He was bound to say that there was a remarkable amount of regularity running through the composition of the rails made in both ways, but there was no superiority whatever in regard to that made by the old or the acid process. Then came the question of durability. Neither the acid nor the basic process had been sufficiently long in use—at all events on the North-Eastern Railway—to enable him to speak with any degree of certainty as to the comparative durability of either the one or the other as against the old iron rail, but they had got so far as they had gone in their examination—at any rate the engineers of the North-Eastern Railway had reported—that there was no inferiority in the basic rails, and that, so far as they were able to judge by some very extraordinary tests to which they had put their rails, viz., by putting them on curves, the the loss of weight per year on the basic rails was not more than on the acid rails, and he did not apprehend that they had anything to fear either in point of strength or in point of durability.

Mr. Cooper then replied. He said M. Gautier required the length of the specimen. Well, it was 8in., the same as prescribed by Lloyd's. With regard to the limit of elasticity he could not say positively what that was in the specimens produced, but it ranged from 14 to 16 tons. With reference to what Mr. Snelus and Mr. Riley had said about testing, it must not be thought for a moment that they shirked testing. They courted it. But the object of the latter part of his paper was to point out the desirability of substituting a soft, cheap material in place of iron in ships, not in place of 27 to 31 ton steel which the steel company was quite equal to make if it were required. As to what Mr. Adamson had said about the permanent set and limit of elasticity, that was not inserted in the table simply because it was intended to compare with the tests of Lloyd's. Lloyd's would not require the limit of elasticity—they took no notice of it. With regard to what Mr. Williams said, he must thank him for the very kind way in which he had spoken, not only of the works, but of himself, and he regarded Mr. Williams' testimony as to the position of the works at the present time, and as to its capabilities for producing good material as being all the more important because his testimony was quite an independent one. As to Mr. Williams' question as to why they used the furnaces and soaking pits together, that was owing to the fact that they had only one mill, and the great number of lengths that they had to make; they could not always use the soaking pits. They could not use them as frequently as they liked, and just at the time of Mr. Williams' visit they were turning out the order in which they were using the furnace, and they were only getting the soaking pits into operation. With respect to Mr. Whitwell's inquiry, he need scarcely say that they could produce a steel containing ·085 of carbon. Indeed, some specimens in the table did not contain more than ·04 or ·05. With regard to Mr. Walmsley's question as to the samples spoiled, he anticipated someone asking that question, and he took the precaution of asking the manufacturer to supply with samples. He did not think it was necessary to say that if they had found the material bad that they would require the company to supply them again. Very few of the samples had been made by the Steel Company themselves. As to the President's remarks, he thought he had sufficiently answered them.

Mr. Walmsley: Mr. Cooper has not answered my question as to the number of failures in producing those samples.

Mr. Cooper: In order to answer that, I will have to write to the people who have supplied the samples.

The President: You will, perhaps, add a note to your paper in the "Transactions" of the Institute.

Mr. Cooper: Yes; I will do that. As to what the President said on the question, I think I have already sufficiently replied. The object aimed at in the last two pages of the paper was to show how a very cheap material could be produced to replace iron. In conclusion, I have only to thank you for the very patient way in which you have heard me, and for the very great amount of kindness that I have received; and I hope, to borrow a phrase from Mr. Seebohm, that we have proved that, at any rate, some angelically good steel can be produced from galvanically bad iron.

The President: And not only can some angelically good steel be produced from galvanically bad iron, but that it will bear some pains and penalties of purgatory.

The President announced that as the papers of Messrs. Siemens, Rily, and Dick were on cognate subjects, they proposed to read them that day and have the discussion on them to-morrow—Thursday.

These three papers were accordingly read, and at their conclusion the members adjourned to the North-Western Station to go to inspect the railway company's works at Crewe, where they were entertained hospitably, and were then taken over the works of the company, returning to Chester about 7 p.m.

THE SEVERN TUNNEL RAILWAY.*

By J. Clarke Hawkshaw.

In former days before railways existed, one of the coach roads between England and South Wales crossed the Severn near the place where a railway tunnel is now being made. In those times travellers left their coaches on reaching the Severn at New Passage on one side and Portskewet on the other, and crossed the river or estuary, which is there about 2¼ miles wide, in open boats.

Later on, lofty wooden piers were made on the banks of the Severn at the two places just named; on to these the trains now run, and passengers there leave them, and are taken across the river by steam ferry boats. The inconvenience of this journey is increased by the great rise of the tide, amounting at springs to over 40ft.

To do away with this break in the railway communication between the two parts of the country, plans were submitted to Parliament, one for the construction of a bridge, and the other of a tunnel.

In the year 1872 Parliament sanctioned the construction of a tunnel, and the work was begun in March, 1873, by the Great Western Railway Company. Shafts were sunk, and from them driftways were driven on the line of the tunnel. In this preliminary work no great difficulty was encountered, and the driftway under the river was nearly completed, only 130 yards remaining to be driven in order to effect a junction, when a large spring burst into the driftway driven landwards from Sudbrook and drowned the works under the river.

This happened on October 16th, 1879; Sir John Hawkshaw, who had previously acted as consulting engineer, was appointed engineer-in-chief in conjunction with the engineer Mr. Richardson, and a contract was made with Mr. T. A. Walker for the completion of the works. Considerable progress has been made with them during the last 4½ years, and the tunnel is now rapidly approaching completion.

Site of Works.—The line selected for the tunnel is about half a mile south of the steam ferry between New Passage and Portskewet. The Severn is there about 2¼ miles wide, and is a tidal estuary rather than a river. Owing to the great rise of tide the current is very rapid, reaching 10 to 11 knots in certain states of the tide. The bed, which is laid bare over two-thirds of the width of the estuary at low-water, consists throughout of rock or shale. There are three depressions in it, the most considerable, called the "shoots," is half a mile from the Welsh shore and has a width of 550 yards, and a depth of 60ft. at low water and 96ft. to 100ft. at high-water.

Geology.—A section made on the line of the tunnel would disclose below recent surface deposits, a series of trias marls and sandstones lying in nearly horizontal strata on highly inclined beds of coal measure, shales, and sandstones.

On the English shore a level tract of land extends for three miles from the margin of the Severn landwards, terminating abruptly in an escarpment of trias resting on carboniferous lime-

* Paper read before the British Association at Montreal.

stone, which is here brought up by a fault. This level tract lies 9ft. below high-water mark of the Severn during exceptional spring tides, and would be subject to occasional overflows of tidal water if it were not protected by an artificial bank called the sea wall. This flat is covered by a bed of rich alluvium with some peat resting on sand and gravel which lies on the irregular surface of trias marl. The rocks exposed over the bed of the Severn when the tide is low are trias, marls, and sandstones, and a conglomerate called the dolomitic, which is found forming a bed of varying thickness at the base of the trias. This bed, generally only a few feet thick, attracts attention on account of its characteristic appearance, being formed of large rounded pebbles and boulders embedded in an equably hard matrix, the whole presenting much resistance to erosion, and being conspicuous when parts of the more yielding beds near it have been destroyed.

On the Welsh shore a low cliff of trias marl and sandstone rises about 30ft. above high-water mark, and from thence to the western end of the tunnel this formation is found near the surface covered by some sand and gravel, and in one depression by alluvium, through which the marsh shaft was sunk. From the western end of the tunnel an alluvial flat extends similar to that met at the eastern end.

The only other formation which need be mentioned is the carboniferous limestone which crops out at the surface at Portskewet Station and also in Portskewet village, 560 yards from the line of the tunnel. This limestone extends over a large tract of high land to the north-west; much of the drainage of limestone is, as is the case in most limestone districts, by underground conduits. The tunnel itself passes for the greater part of its length through trias mostly in the form of nearly horizontal beds of marl, much jointed, the joints often open, and yielding in many places a great quantity of water near the eastern face; the upper part of the tunnel for a short distance is in the gravel overlying the marl, then wholly in marl passing below the coal measures are reached into a compact fine grained sandstone. The passage from trias marls to the coal measures, which takes place at a distance of about a mile from the sea wall, is abrupt owing to faulting. For the remaining distance under the river the rocks traversed consist of coal measure shales and sandstones, under the shoots; where the cover above the tunnel is only 45ft. the sandstone is strong Pennant, much broken and jointed, though sometimes in massive beds; much water flowed from the open joints in this sandstone in many places. The tunnel continues in the coal measures for a distance of about

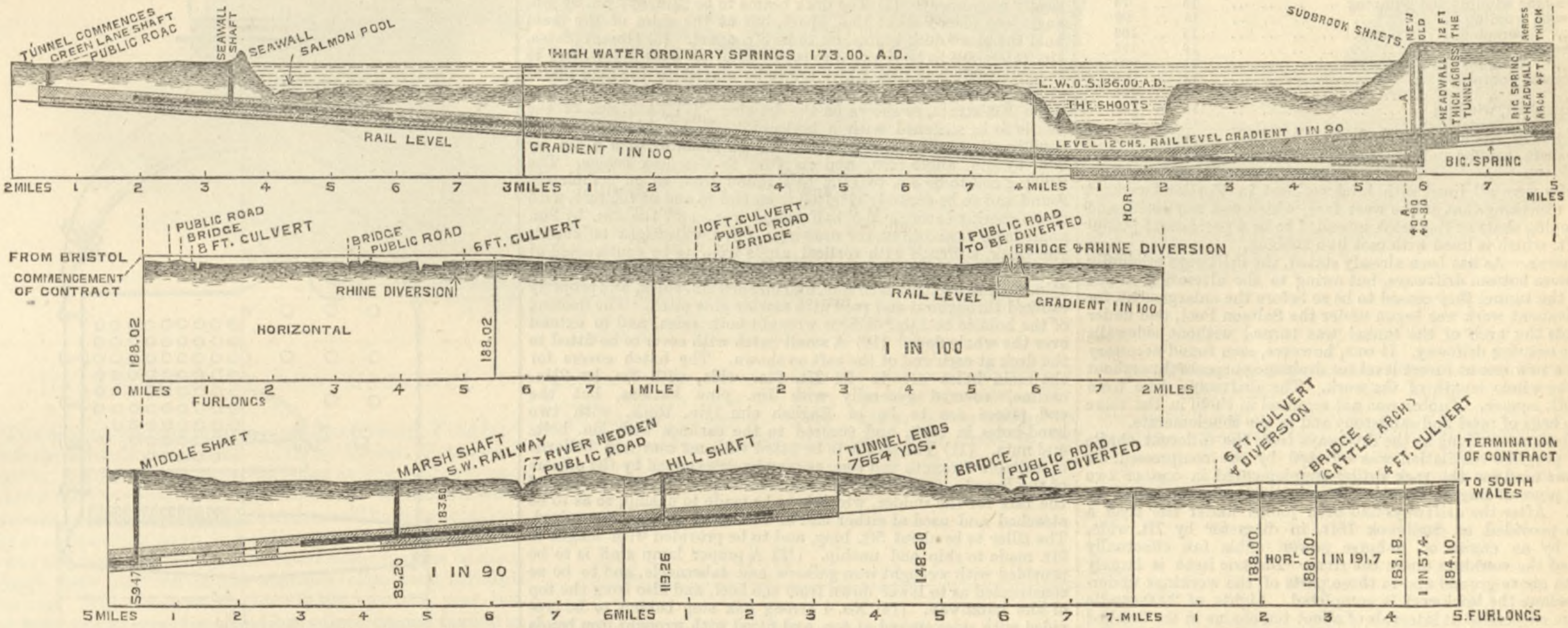
line from Bristol. They are all made from coal measure shales. As these shales are met with in the works, the contractor has erected crushing mills, drying sheds, and kilns, and makes 150,000 to 170,000 a week for use in the works.

The greatest amount of brickwork that has been done in one week is 2000 cubic yards, requiring two-thirds of a million bricks. The brickwork is all set in mortar made of one part of Portland cement and two parts of sand. When much water was met with, it was led to pipes which are built into the brickwork. Some of these have been plugged up, but through many of these water is still flowing. The largest pipe required for this purpose is 6in. in diameter, from which a stream of water of the full section issued under considerable pressure at the time of high tides. Pipes could be only used when the water to be dealt with came in a definite stream from a fissure. In many cases in marl the water issued all over the section of the marl exposed in the excavation. It then became necessary to cover the whole surface with roofing felt in two thicknesses before any brickwork could be set. The time occupied in doing this, and in making other arrangements for keeping the water off the brickwork, more than trebled the total time which would have been required to finish a length of brickwork in a dry section of the tunnel.

Difficulties encountered.—Of the difficulties met with in carrying out the work, that of dealing with the water has so far been the greatest. Prior to 1879, when the large spring was tapped, the quantity was not great at Sudbrook, two 26in. plunger pumps, one 18in., and a 15in. bucket pump, were sufficient to drain the driftway 3370 yards long under the river, and the driftway driven from the shaft inland, 355 yards in length. This landward driftway was in hard red shale interspersed with sandier rocky beds, nearly the whole of which was crushed and made into bricks used in the work. Very little water was met with in this driftway until on the 16th of October, 1879, the side burst in at a point 355 yards from the shaft, and a stream of water 7ft. wide and more than 12in. deep ran down the driftway—1 in 100—overmastered the pumps and drowned the works under the river. After this occurrence the work was let to Mr. T. A. Walker, and attempts were at once made to check the flow of water.

Oak shields were lowered through the water and were fixed by divers at the sides of the shaft over the openings to the tunnel driftways. These so far checked the flow of land water that the pumps were able to reduce its level to about 30ft. from the bottom of the shaft, that is, below the level of the shields covering the

back in the driftway behind this headwall. Three new pumps are being placed behind in one of the two winding shafts at Sudbrook, and when they are ready to work the total pumping power at Sudbrook will be about 27,000 gallons per minute, and it is believed that there will then be little difficulty in dealing with the large spring and completing the tunnel work past it. It is almost certain that the water tapped in the lower driftway came from the same source as that in the upper driftway, but being tapped at a lower level, a very large quantity of water above the normal flow at the higher level had to be dealt with which was previously stored up in the fissures of the limestone. It was the discharge of this stored water suddenly into the works that overpowered the pumps, and it is probable that steady pumping would in time have reduced the discharge into the lower driftway to near the amount that had formerly flowed into the upper one. During the time that the works were flooded after the first irruption of water at Sudbrook in 1879, some falls must have occurred in the roof of the driftway below the Salmon Pool. Owing to the greater part of the *débris* from these falls having lodged on the timbering over the driftway, it was not suspected that cavities of any size were forming in the marl above. Considerable progress had been made with the finished brickwork from the sea wall shaft when an irruption of water took place—April 29th, 1881—which mastered the pumps and drowned the works. On examining the bottom of the Salmon Pool over the place where the irruption of water occurred, a hole 16ft. by 10ft. was found in the marl. The sides, as far as could be ascertained by sounding, were overhanging, and the hole was full of large blocks of marl to within a few feet of the surface. This hole was filled up with clay puddle and covered with a mound of clay puddle in bags. The pumps were then able to clear the works of water. As the driftways under the river were not joined at this time, the flooding was confined to the works in connection with the sea wall shaft on the English side. Another fall was found in the roof of the driftway near this place extending upwards 23ft. to within 20ft. of the river bed. This cavity was carefully timbered as soon as it was found, and was built up with brickwork in cement as soon as a length of tunnel had been completed below it. Much water was met with in the works under land to the west of Sudbrook. First in the dolomitic conglomerate overlying the coal measure shale, and further west in the lower beds of the overlying marl, but no sudden irruption of water in quantity occurred, although owing to accidents to pumps, the works from the two shafts westward of Sudbrook were on several occasions flooded.



THE SEVERN TUNNEL RAILWAY.—LONGITUDINAL SECTION OF TUNNEL AND APPROACHES.

a-quarter of a mile after reaching the Welsh shore, where they are found in the form of red shales and sandstones, generally very free from water. From these shales the tunnel passes gradually into the overlying conglomerate at the base of the trias. This was the most troublesome formation to tunnel through. At the middle shaft it is 26ft. thick, full of open fissures discharging a great volume of water. From the conglomerate the tunnel again passes into the trias marls, and continues in them for the remaining distance to the western face.

Tunnel.—The total length of the tunnel when finished will be 7664 yards—about 4⅓ miles—the length of the tunnel sanctioned by Parliament in 1872 was 4½ miles, but in 1883 an application, which was granted, was made to reduce the length by 13 chains by substituting that length of open cutting for tunnel at the Welsh end. This was done with a view to obtain material for making embankments for sidings at Rogiett station, where the Tunnel Railway joins the South Wales line. Another important alteration was made in the design after the works had made considerable progress. When Sir John Hawkshaw was appointed engineer in 1879 he recommended that the line of the tunnel should be lowered 15ft. under the Severn in order to obtain more cover. The lowest part of the line was placed under the shoots, the deepest part of the estuary. The minimum cover then was 30ft., which has been increased, by lowering the level 15ft., to 45ft. Under the shoots the line will be on the level for 12 chains. From this level piece the line rises with a gradient of 1 in 100 towards the English end and 1 in 90 towards the Welsh end. Originally the gradients were 1 in 100 each way. The gradient on the Welsh side was made steeper in order to avoid deepening the cutting at the Welsh end and so save excavation. As the heavier loads are mostly from Wales to England, this alteration of gradient will not be much felt in working the line, and as very little of the Welsh incline lies under the river, there is only a short length of tunnel under the Severn which will not be lowered the full 15ft. The English incline has been lowered 15ft. throughout. This alteration added about 430,000 cubic yards of excavation to the cutting at the English end. Prior to this alteration a drainage driftway had been driven from the pumping shaft at Sudbrook to the lowest part of the tunnel heading under the shoots. A second heading has now been driven at a lower level to drain the tunnel as it is being constructed. This heading is circular and 5ft. in diameter inside the brickwork—13½in. thick—with which it is lined throughout. Both these drainage headings are shown on the section. The tunnel is for a double line of way lined throughout with brickwork. The top is a semicircle of 13ft. radius with curved side walls and invert as shown in the transverse section.

Brickwork.—The transverse section of the tunnel shows the lining of brickwork to be 2ft. 3in. thick. This was the contract section, but under the shoots under the Salmon Pool and in other parts where the nature of the ground rendered it advisable, the thickness was increased to 3ft. in the arch and side walls. In a few places the invert was reduced to 1ft. 10in. and 1ft. 6in. in thickness. The bricks used are all vitrified. They are frequently tested with a hydraulic machine kept on the works for the purpose and have borne from 25 tons to 70 tons without cracking, and as much as 77 tons before they were crushed; some came from Staffordshire, some from the neighbourhood of Bristol, and from Cattybrook in Gloucestershire near where the tunnel line joins the

openings to the driftways. To still further reduce the flow of water an attempt was made by divers to shut a door across the driftway under the Severn about 330 yards from the bottom of the shaft, and thereby cut off the water flowing into the long driftway under the river. Divers in the ordinary dress failed to reach this door, but one named Lambert volunteered to go to it alone with Fleuss's apparatus. He succeeded in reaching the door and closing it, being under water without any communication with those above for an hour and twenty-five minutes. In the meantime a doorway was being built across the heading, down which the water was flowing, and as soon as it was completed the door in it was shut, and the whole of the water from the spring was at once penned back in the heading behind it.

Soon after the outburst of this water into the driftway springs and wells in the neighbourhood for some miles round were dried, and the river Nedern, which at all times loses much water by fissures in the carboniferous limestone, which it passes over in the district adjoining the works, lost nearly all its water. When the flow down the driftway from the spring was stopped by the door being closed, the water soon resumed its former condition of level and flow in the wells, springs, and river affected by the outburst. No steps were taken to release the water penned back in the driftway till May 30th, 1883, after a new pumping shaft had been sunk in which three new pumps were fixed at Sudbrook.

It was then found that a fall had occurred in the roof of the driftway behind the door, forming a cavity 40ft. in height. The *débris* from the fall was removed, the pumps being quite able to deal with all the water from the spring, which amounted to 6000 gallons a minute. The old driftway was cleared in the direction of the spring when it was known that another large fall in the roof had occurred.

A new working driftway on the level of the invert was driven below the old one. Very little water was met with in it until a point 97 yards beyond the door, and 97 yards from where the first outburst of water in the driftway above occurred was reached. Here the water burst into the lower driftway suddenly from below, and in so much greater quantity that it filled up the works to within 95ft. of high water level in fifty-one hours. At that level the pumps were able to hold it. It was estimated that during this time the inflow was at the rate of 27,000 gallons per minute. The pumps at Sudbrook, which could lift 11,000 gallons per minute, were kept steadily working for three weeks, and the level of the water in the shaft was gradually reduced, but latterly very slowly, not more than 7in. in twenty-four hours. Each driftway had been provided with a door. That in the upper one was closed by the men before they left the work, but that in the lower driftway could not be closed owing to the rush of water through it. This door was 150 yards from the shaft. Lambert, the diver, who had on a previous occasion closed a door under the Severn, was sent down to close this one; he succeeded in doing this in the ordinary diver's dress with the assistance of two other divers, one of whom remained at the shaft and the other half-way between the shaft and door to help him with his air pipe.

On this door being closed the level of the water was rapidly reduced. As soon as the tunnel could be entered a headwall was begun 88 yards from the shaft, 15ft. thick, and filling up the whole section of the tunnel. An iron door was fixed in it and also two 12in. pipes provided with sluice valves. The water is still penned

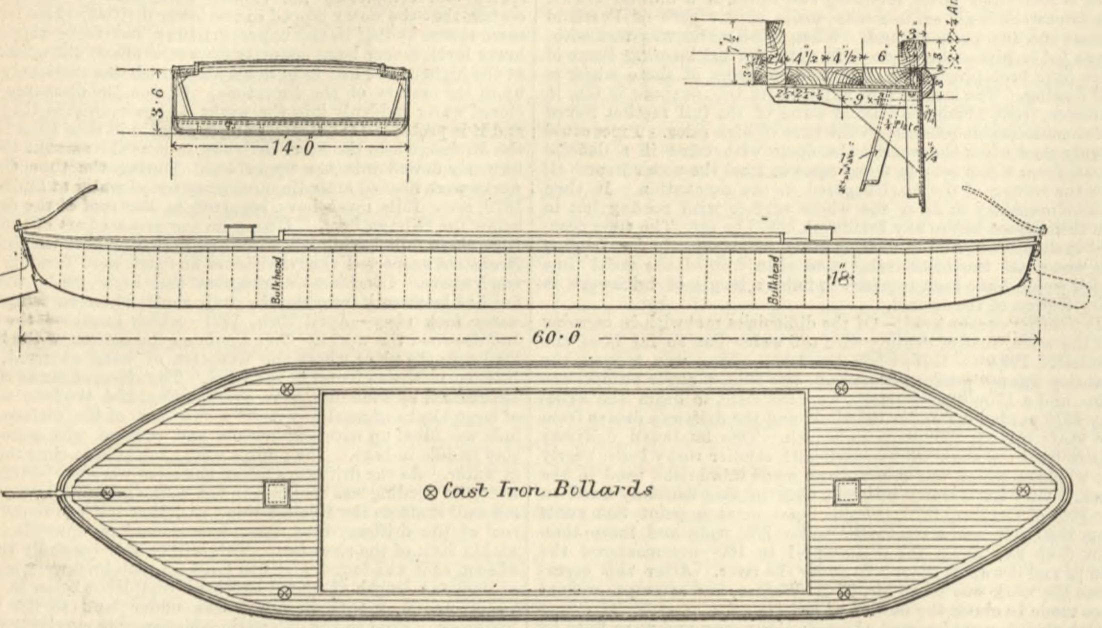
The only really dry parts of the work were those in the fine-grained trias sandstone under the river in some of the coal measures shales and in the higher beds of the trias marl and sandstone near the west end of the tunnel.

Excavation.—Some of the excavation for a short distance near the east end of the tunnel was in gravel. This, owing to its loose and open nature, required very heavy timbering. Almost the whole of the remainder, the exception being a short length of the softer coal measure shales, was in material so hard as to require blasting. Holes were drilled partly by hand and partly by machines worked by compressed air. When the Great Western Railway Company were carrying on the works themselves they used a machine made at their works at Swindon, and as a number of these were handed over to Mr. Walker when he took the contract, a great part of the work was done with them. They are very rapid in doing their work, but require constant repair. Several other drills were tried, the Darlington being most in favour owing to its scarcely ever wanting repairs. Several sorts of explosives were used, but torrite principally, its fumes being found less noxious than those of dynamite. As much as 600 lb. have been sometimes used in one week. The greatest amount of excavation in tunnelling done in any one week was 6000 cubic yards. The driftways as originally driven were bottom driftways, but owing to the tunnel being made at a lower level than was originally intended, and the gradient altered, they became neither bottom nor top driftways in most places, and it was necessary to drive a new bottom driftway almost throughout the whole length of the work. From the driftways breakups were made at intervals of about two to five chains. Some timbering was necessary in almost every length. In the gravel and shales this was of the heaviest description. Some of the Pennant, the dolomitic conglomerate, and some of the trias sandstone, stood with little or none. Four steam navvies are now at work in the cutting at the English end, which contained 790,000 cubic yards of excavation. This cutting is almost wholly in alluvium gravel and sand. The cutting at the Welsh end is partly in alluvium and partly in trias sandstone; it is now nearly completed. Embankments are made along the sides of the cuttings throughout their lengths to protect the tunnel in the event of the low lands through which they pass being flooded.

Pumps.—On the following page is a complete list of the pumps used to drain the tunnel works and the estimated amount of water which they will lift. The total quantity of water now being pumped is about 19,000 gallons per minute. Four beat valves of gun-metal are used in all the large pumps, and they have been found to work very satisfactorily.

Shafts.—On the 4⅓ miles of tunnel there are shafts at seven points, viz., at each face and at five intermediate points. The greatest distance between any two shafts is 2 miles 25 chains between the shaft at the sea wall and Sudbrook, which are separated by the Severn. The other shafts are from 25 to 40 chains apart at sea wall, and also at middle shaft there is in addition to the winding shaft a pumping shaft, and at Sudbrook there are now three pumping shafts and one winding shaft; one of these three pumping shafts was till lately used as a winding shaft. All the pumping shafts except the last mentioned are off the line of the tunnel, and connected with the works by culverts which can be closed by sluices, so that in the event of a pump breaking down, the

CONTRACTS OPEN—STEAM FIRE ENGINE RAFT.



shaft can be kept dry by closing the sluice until the repairs are done. The following is a list of the tunnel shafts :—

	Diameter.	Depth.
	ft.	ft.
Green-lane winding and pumping	10 ..	74
Sea wall, winding	18 ..	96
„ pumping	15 ..	108
Sudbrook, winding..	18 ..	194
„ winding now and for pumping	15 ..	200
Sudbrook, pumping	18 ..	204
„ „	12 ..	220
Middle shaft, winding	15 ..	150
„ „ pumping	15 ..	155
Marsh shaft, winding and pumping..	15 ..	105
Hill shaft, winding and pumping	15 ..	86
West face, „ „	10 by 18	71

The shafts were all lined with brickwork set in Portland cement mortar, excepting that at the west face, which was not lined, and one pumping shaft at Sudbrook intended to be a permanent pumping shaft, which is lined with cast iron tubbing.

Driftways.—As has been already stated, the driftways originally driven were bottom driftways, but owing to the alteration in the level of the tunnel they ceased to be so before the enlargement, for the permanent work was begun under the Salmon Pool, and under the shoots the arch of the tunnel was turned without sidewalls from the existing driftway. It was, however, soon found necessary to drive a new one at invert level for drainage purposes throughout nearly the whole length of the work. The driftways were from 7ft. to 9ft. square. Timber was not required in them in the more compact beds of marl and sandstone and in the conglomerate.

Ventilation.—So long as the driftways from the different shafts were in progress ventilation was effected by the compressed air which was used for the rock drills, supplemented in one or two cases by pipes of larger diameter through which air was forced by blowers. After the driftways had been joined under the river a fan was provided at Sudbrook 18ft. in diameter by 7ft. wide, worked by an engine of 10-horse power. This fan effectually ventilated the workings under the river. Electric light is largely used both above ground and in those parts of the workings underground where the brickwork is completed. Lights of 2000-candle power are suspended at intervals of about ten chains in the finished parts of the tunnel ; much vitiation of the air is prevented by the use of these lights.

Particulars of Pumps in use at the Severn Tunnel.

Name of pump or locality.	Diameter of working barrel.	Stroke.		Gallons per stroke.	Number of strokes allowable.	Gallons per minute.	Total gallons per minute.
	in.	ft.	in.				
Ableton-lane "bucket" ..	15 by 2	6	6	100	12	1200	1,200
Sea wall "plunger"	$15\frac{1}{2}$ by 2	7	0	114	12	1368	1,368
No. 1 bull "plunger"	26	10	0	231	12	2772	
No. 2 bull "plunger"	26	10	0	231	12	2772	
75in. beam "bucket"	35	9	0	575	12	4500	
70in. beam "plunger".. ..	18 by 2	10	0 }	487	9	4383	
70in. beam "bucket"	28	10	0 }				
New 70in. beam "plunger"	39	10	0	518	12	6216	
New 70in. beam "bucket"..	35	9	0	375	12	4500	
New 60in. beam "bucket"..	31	9	0	295	12	3540	
Total at Sudbrook	—	—		—	—	—	28,683
41 beam bucket and side pump	28	9	0	248	14	3472	
Horizontal plungers and side pumps	18 by 2	8	0	193	10	1930	
Old horizontal plunger ..	20	7	0	95	$7\frac{1}{2}$	712	
New 60in. "bucket"	31	9	0	295	12	3540	
Total at 5 m. 4 c. (middle shaft)	—	—		—	—	—	9,654
Marsh "plungers"	15 by 2	6	6	100	14	1400	
22 bull "plungers"	15	7	0	54	12	648	
Compressed air engine.. ..	—	—		250	$2\frac{1}{2}$	625	
Total at marsh	—	—		—	—	—	2,673
Hill "plungers"	15 by 2	6	6	100	12	1200	1,2[illegible]0
Cutting No. 2...	15 by 2	7	0	108	12	1296	1,296
Total	—	—		—	—	—	46,074

N.B.—No deduction has been made from the above quantities for slip.

CONTRACTS OPEN

STEAM FIRE ENGINE RAFT.

THE following is the specification of an iron raft to carry a steam fire engine :—

(1) The raft to be constructed as shown on the accompanying drawing marked A, and to be 60ft. long, with a 14ft. beam, and a depth at side 3ft. 6in. (2) The hull to be constructed with plates and angle iron equal in quality to the best Staffordshire. The deck floors and combings to be best red Dantzic pine. (3) The skin plating, including the shear strake, to be $\frac{1}{4}$in. thick, rivetted to angle iron ribs, $1\frac{3}{4}$in. by $1\frac{3}{4}$in. by $\frac{1}{4}$in. placed 18in. centres. (4) The floor to be stiffened throughout the length of the vessel by floor-plates, 9in. deep by $\frac{1}{4}$in. thick, rivetted to the rims, and strengthened at top by an angle iron $1\frac{3}{4}$in. by $1\frac{3}{4}$in. by $\frac{1}{4}$in.; the angle iron ribs are to break joint alternately about 3ft. 6in. from the centre of the vessel, and there are to be two limber holes in each floor, viz., one as near each end of the floor as may be practically convenient. (5) The deck beams to be $2\frac{1}{4}$in. by $2\frac{1}{4}$in. by $\frac{1}{4}$in. angle iron placed about 18in. apart, but at the sides of the main hold the short deck beams are to be 3ft. apart. (6) Gusset-plates, $\frac{1}{4}$in. thick, are to be rivetted to each end of all deck beams, and to the side angle iron ribs, which are to be stayed to the floor-plates at every fourth rib throughout the hold, with $1\frac{3}{4}$in. by $1\frac{3}{4}$in. by $\frac{1}{4}$in. angle iron struts, as shown on the drawing. (7) Each side of the raft is to be stiffened with a horizontal 9ft. by $\frac{3}{16}$in. plate from stem to stern immediately under the deck planking with a 2in. by 2in. by $\frac{1}{4}$in. angle iron, and rivetted to the deck beams. The rubbing coil to be 3in. to $1\frac{1}{4}$in. half round iron, to go completely round and to be securely rivetted from end to end of the raft, with rivets passing through the half round iron, and the 2in. by 2in. angle iron, as shown on the drawing. (8) A watertight bulkhead, $\frac{1}{4}$in. thick, stiffened with vertical angle iron, to be constructed at each end of the open main hold. (9) The deck planking to be in $4\frac{1}{2}$in. widths wrought each side, and finished 2in. thick, and properly caulked throughout and paid with marine glue pitch. The flooring of the hold to be $1\frac{1}{4}$in. battens wrought both sides, and to extend over the whole floor. (10) A small hatch with cover to be fitted to the deck at each end of the raft as shown. The hatch covers for the main holes are to be 2ft. 6in. wide, with 3in. by $2\frac{1}{2}$in. carline, covered generally with 1in. pine battens, but the end pieces are to be of English elm $1\frac{1}{2}$in. thick, with two hand-holes in each, and secured to the carlines with $\frac{3}{8}$in. bolts and nuts. (11) The raft is to be fitted with six cast iron bollards of suitable strength and size, as may be determined by the officers of the Board. (12) Proper carriages to be provided at each end of the raft for the rudder, which is to be made to unship, so as to be attached and used at either end of the vessel as may be required. The tiller to be about 5ft. long, and to be provided with length of 5ft. made to ship and unship. (13) A proper lamp staff is to be provided with wrought iron gallows and tabernacle, and to be so constructed as to lower down from the heel, and also from the top of the hatchway. (14) No. 4 strong oak step ladders to be provided with sides curved at top, and fitted with wrought iron bands hooked over combings, each ladder to have three steps. (15) Eight wrought iron stanchions to be provided for hold, fitted with proper brackets and sockets. (16) The hull of the raft is to be served externally with two coats of Parker's black varnish. The whole of the interior is to be painted with two coats of best red lead and oil, and all woodwork usually painted is to have five coats best white lead and oil. (17) All material and workmanship are to be the best of their several kinds, and the contractor is to construct and complete the raft in every way fit for service, and to the entire satisfaction in every respect of the engineer of the Metropolitan Board of Works and chief officer of the Metropolitan Fire Brigade; and should any matter be omitted in this specification or drawing necessary for the proper completion of the work, the contractor is to supply or perform the same without any extra allowance, and he is to deliver the vessel complete on the Thames, at a station to be appointed, not exceeding five miles from London Bridge, within thirteen weeks from date of his receiving the order.

NOTE.—Should the person tendering prefer to differ from the sample raft, either in design, materials, or workmanship, he is to send in his tender with a full description of the points of difference.

Tenders to be sent in on or before the 13th October, 1884.

THE CONGRESS OF GERMAN ENGINEERS.

THIS annual congress met at Mannheim during the first days of the present month. The subjects for deliberation included the amendment of the patent laws, and other topics of professional interest. The papers read comprised several which dealt with the industrial statistics of the district, and with the present situation of the coal tar industry in Germany. Amongst others of more strictly technical interest were those upon a new method for the direct measurement of velocities, and upon the graphic treatment of the mechanical theory of heat.

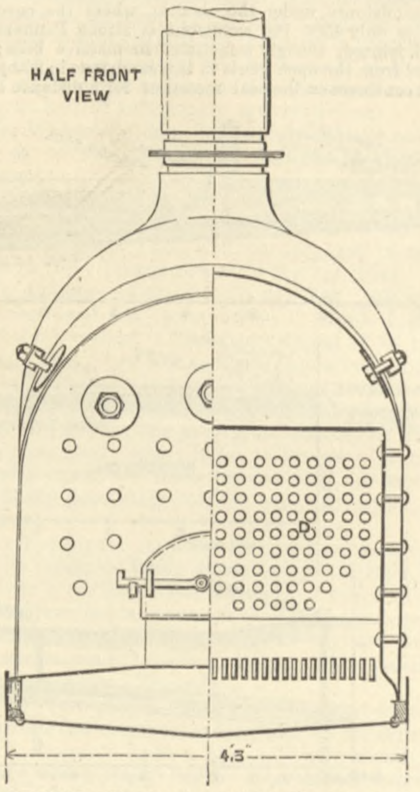
In the former paper, Herr O. Smaeker remarked that the direct measurement of velocities belongs to those problems which up to a recent period had not been solved in a technical manner. The eminent practical importance of the question had led to numerous efforts being made in that direction, but the principles and methods hitherto employed were either empirical or wanting in exactness. The investigations of the author of the paper, in conjunction with those of Professor Harlacher, of Prague, and Dr. Henneberg, of Darmstadt, had resulted, however, in the discovery of a direct and easily applied method for arriving at the object in view. The principle of this system is the comparison of the velocity to be measured with another velocity, and the measurement of the former by the latter. An apparatus has been constructed, the principal features of which consist of a rotating disc with an adjustable indicating roller, to which the velocity to be measured is conveyed, the working of the appliance being described as instantaneous and completely reliable.

Professor Gustav Hermann, of Aix-la-Chapelle, in the second of the papers alluded to, dealt with the comparative relations of the methods of the graphic and calculating systems of treating the mechanical theory of heat. He remarked that, although the latter, by reason of its accuracy, is an excellent mode of investigation, it does not, however, allow that rapid and comprehensive appreciation which is attainable by delineation. This principle he considered particularly suited to the question of the mechanical theory of heat, with a view of elucidating various points, about which a certain amount of doubt exists in technical circles. Professor Hermann briefly touched upon the so-called leading principle of the science of heat, which deals with the equivalent relations of heat and mechanical effect, and according to which one caloric unity represents 3066·80 foot-pounds. He gave more detailed attention to the second principle of the theory, which embraces the transformation of heat into mechanical effect, and *vice versâ*. Special reference was made to the losses in effect which result when the transition of heat takes place from warmer to colder bodies, and a simple diagram was exhibited, in which this principle was illustrated, as applied to the instance of a steam engine. Reliable conclusions were thereby facilitated as to the superheating of steam, and as to the impossibility of arriving in practice at the effective utilisation of all the power attributed by theory to the total quantity of heat. The actually efficient proportion was stated to be in the most perfect steam engines only 10 per cent. of the heat supplied. There were graphic representations likewise shown, which illustrated the relative efficiency of atmospheric air and steam.

The social features usually connected with German scientific gatherings were not wanting at the Mannheim assembly, and the entire proceedings were in every respect successful.

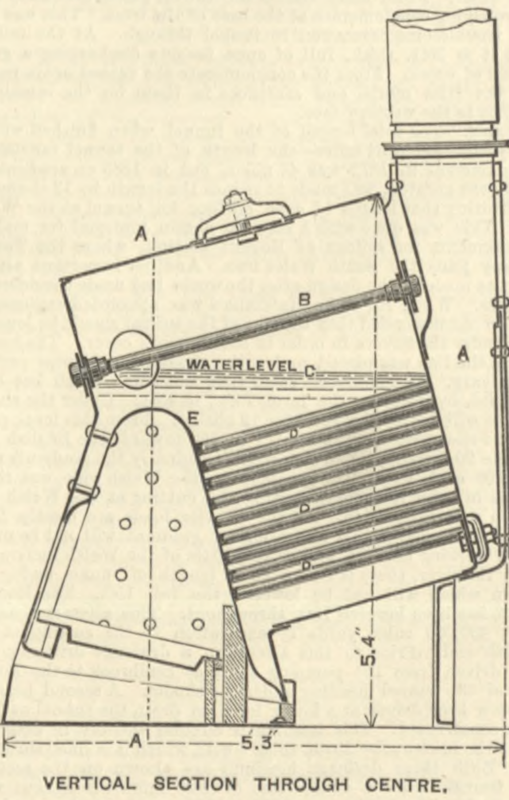
TIPPING'S LAUNCH BOILERS.

THE accompanying engraving illustrates a new type of launch boiler, patented and manufactured by Mr. H. Tipping, of Circus-



SECTION THROUGH FIRE-BOX ON A—B.

street, Greenwich. No description of any kind is necessary, the engravings explaining themselves. It is claimed that this boiler



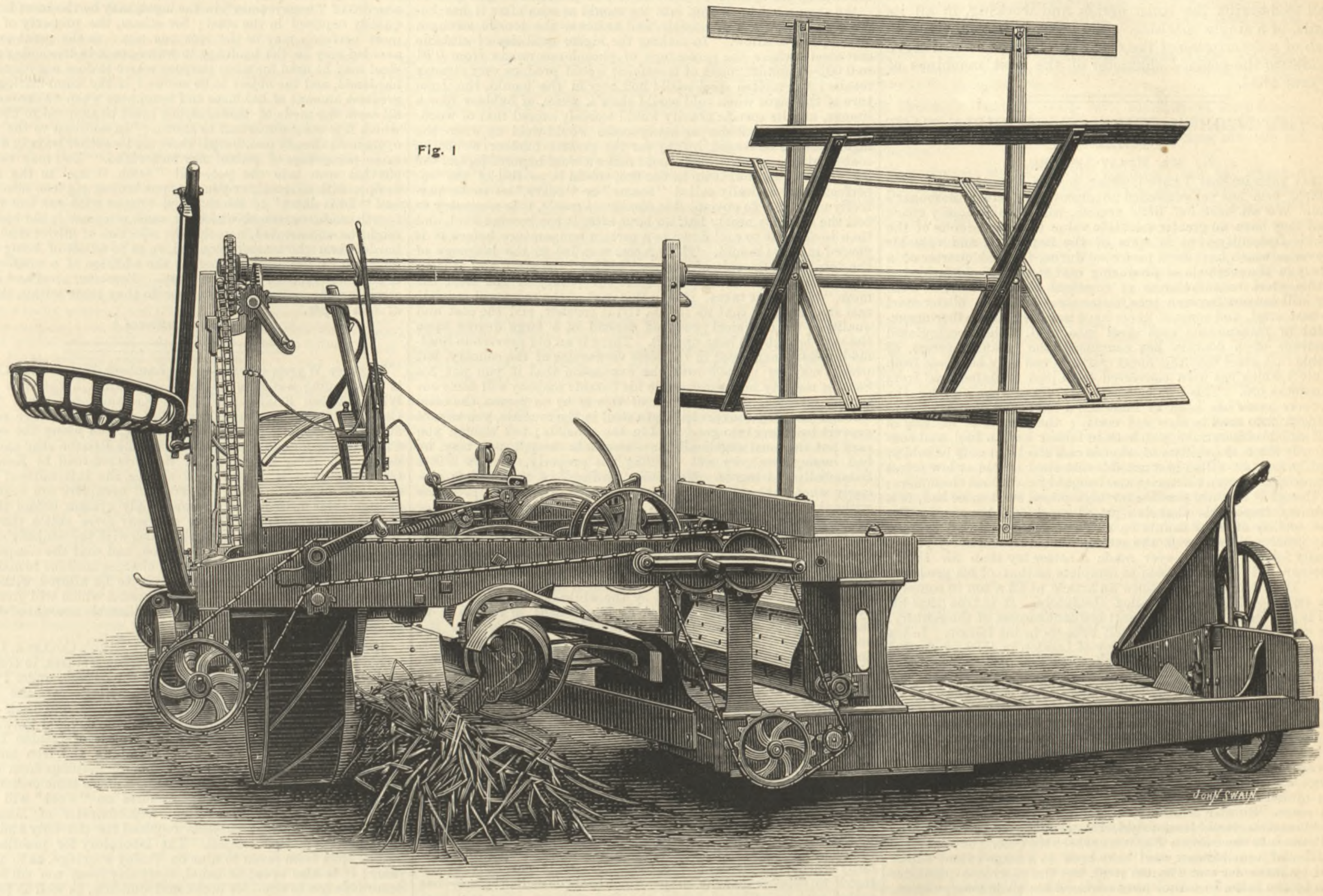
VERTICAL SECTION THROUGH CENTRE.

is about the lightest and cheapest for the power that can be made, and it no doubt possesses some excellent features.

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending Sept. 20th, 1884:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 10,758; mercantile marine, Indian section, and other collections, 4770. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 6 p.m., Museum, 1496; mercantile marine, Indian section, and other collections, 297. Total, 17,321. Average of corresponding week in former years 19,577. Total from the opening of the Museum, 23,379,639.

SAMUELSON'S SHEAF-BINDING REAPING MACHINE.

Fig. 1



SHEAF-BINDING REAPING MACHINES.

No. VI.

THE accompanying engravings are illustrations of the low-level sheaf-binding machine made by Messrs. Samuelson and Co., Banbury, exhibited by them at Shrewsbury, and entered for the recent trials at Montford. In consequence, however, of a slight misfortune, such as will happen occasionally at competition trials, it was thrown out of the trials, and it was not tested on the dynamometer as the makers wished, though their machine of the elevator class went through this test. The low-level machine is not new this year, but has been in use some time, and has gained special favour in New Zealand. It offers several advantages, not the least of which is that the elevator webs are dispensed with, and the whole of the machine is completely under the eye of the driver. This will be understood from our perspective engraving. With this machine the Appleby form of knotting apparatus, with certain improvements of Messrs. Samuelson's, is used, as described in our impression of the 16th of Sept., 1881. This apparatus has had also to be modified to suit the position, see Fig. 1 and Fig. 3. In Fig. 1 it cannot be seen, as it is hidden by the cam disc under the frame. We need not, however, describe this apparatus, as it will be found fully illustrated in the above-mentioned impression. The grain is taken by the travelling platform direct to the binding platform, and the sheaves are made and discharged while close to the ground. The binder is directly in front of the driver, and as the machine is provided not only with the automatic trips, but with a trip under the control of the driver, he is able to clear corners or vary the work as he pleases, according to the crop and to circumstances which he has so well under his eye. The binding apparatus is like that of the other machines we have described capable of adjustment to regulate the position of the string on the sheaf, but in this machine it is adjustable by a lever instantaneously, so that it may be altered by the driver as work proceeds in a varying crop. The whole of the weight of the machine is between the wheels, both of which are large. The machine is thus made very steady, and we should expect its draught to be moderate, but this was not tested. The knife is driven direct by a connecting-rod in front of the machine, and a great advantage of the arrangement adopted, apart from that, follows dispensing with the elevator and tying low, is the general accessibility of the whole machine.

Turning now to our outline drawings of the machine, Fig. 2 is a plan, and Fig. 3 a back elevation of part of a machine. The grain after having been cut by the cutter bar A falls on to a platform consisting of the endless apron B, which removes the cut grain to the stationary platform C, which is recessed at C^2, Fig. 1. From this platform it is taken by packers D D and delivered to the binding device, where it is bound and subsequently discharged.

In order to assist in removing the cut crop from the rearward platform or apron B, an apron—for which belts or links may be substituted—E E is used. This apron is mounted on top and bottom rollers F F^1, the motion of one or both of these latter being derived from the main driving wheel. The rollers F F^1 give motion to the apron E E and cause it to assist in removing the cut crop from the rearward platform B to the stationary lateral recessed platform C. In the drawing the rearward platform B extends only as far as the lower part of the apron E E and a rotating device G^1 G^2 G^3, which is the subject of patent No. 524, of 1883, is employed to assist in the removal of the crop, but the rearward platform may be extended farther towards the lateral platform C, so that

FIG. 2

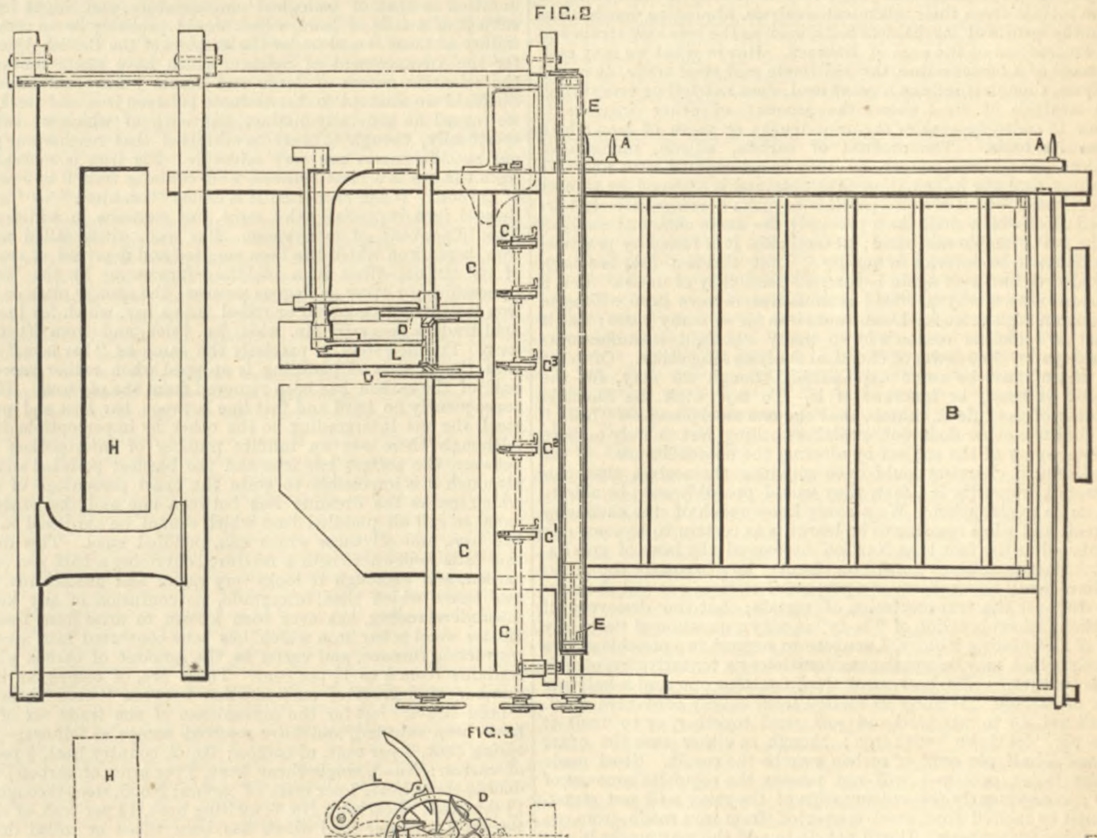
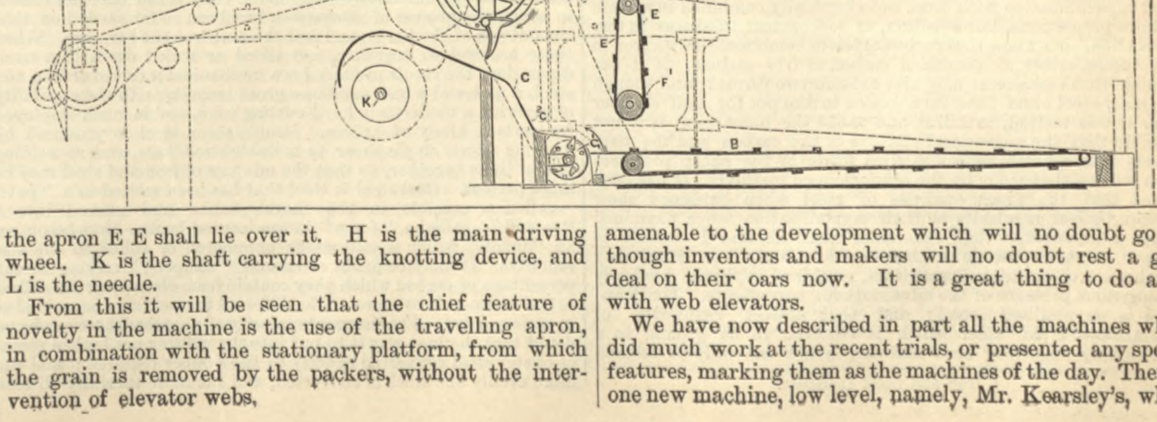


FIG. 3



the apron E E shall lie over it. H is the main driving wheel. K is the shaft carrying the knotting device, and L is the needle.

From this it will be seen that the chief feature of novelty in the machine is the use of the travelling apron, in combination with the stationary platform, from which the grain is removed by the packers, without the intervention of elevator webs.

The packers in this machine are not at all those usually used in combination with the Appleby knotter, but are like those already illustrated with reference to the Wood machine. Samuelson's machine is, on the whole, a simple one, and there is a great deal in this machine which recommends it as having features which make it especially amenable to the development which will no doubt go on, though inventors and makers will no doubt rest a good deal on their oars now. It is a great thing to do away with web elevators.

We have now described in part all the machines which did much work at the recent trials, or presented any special features, marking them as the machines of the day. There is one new machine, low level, namely, Mr. Kearsley's, which has been omitted, but to this we may refer another time; at present we have no drawings, and some parts are made under new patents. We unreservedly admit that the descriptions we have now given are far from complete, and, indeed, it would require as much space as we have given to all to describe the construction and working, in all its details, of a single machine. We have, however, given so much of a description of the essential features as will serve to indicate the general character of the best machines of the year 1884.

ON THE MANUFACTURE OF CRUCIBLE CAST STEEL.*

By Mr. Henry Seebohm.

I may premise that I have nothing new to bring forward. No Sheffield firm has yet succeeded in discovering the philosopher's stone. We all have our little secrets, which we jealously guard—and they have no greater scientific value than the secrets of the Masonic fraternity—but in spite of the important and valuable discoveries which have been perfected during the last quarter of a century in the methods of producing cast steel, the old-fashioned crucible steel manufacturers of Sheffield still hold their own. They still convert bar iron into blister steel and melt blister steel into cast steel, and some of them have not been altogether unsuccessful in transmuting cast steel into gold. The accumulated experience of a century has convinced the manufacturers of crucible cast steel that the finest qualities can only be made from bar steel which has been converted from iron manufactured from Dannemora ore. This iron is expensive; its average cost for the last forty years has been at least £25 a ton; the process of converting it into steel is slow and costly; the process of melting in small crucibles is extravagant both in labour and in fuel, and consequently the best qualities of crucible cast steel can only be sold at a high price. So-called best crucible cast steel is sold at low prices by unscrupulous manufacturers and bought by credulous consumers; but though it is quite possible for high-priced steel to be bad, it is absolutely impossible that low-priced steel can be good. The finest quality of steel cannot be made of cheap material or by a cheap process. Every year the attempt is made, and every year it signally fails. No one ever made a better try than Sir Henry Bessemer, but his failure was as complete as that of his predecessors. He attempted to produce an article at £6 a ton to compete with one at £60 a ton, and failed absolutely. It is true that his steel is a success, perhaps the most brilliant success of the century. I am not quite sure that he himself believes in his failure. In his lecture before the Cutler's Company of London in 1880 he chaffed the steel manufacturers of Sheffield on their antiquated attachment to the rule of thumb, and twitted them with the assertion that the high price of crucible cast steel arose from a combination of trade interest on their part and of prejudice on the part of their customers. Sir Henry Bessemer may have half-ruined the wrought iron trade, and revolutionised the pig iron trade, but the crucible cast steel trade holds its own in spite of his great discoveries. When railways were first introduced, and wagons and coaches were to a large extent driven off the road, many people thought that the price of horses would permanently fall, but exactly the contrary took place. Similar fears were entertained that the demand for crucible cast steel would seriously decline when Bessemer and Siemens steel came into the market. This has not been the case. The commoner qualities of crucible cast steel have been to a large extent superseded by Bessemer and Siemens steel, but the enormous quantities made by the latter processes have required for their manipulation, directly or indirectly, such a large quantity of the better qualities of crucible cast steel, that the total amount of the latter now produced in various parts of the world is probably double that which was required before the birth of its rivals. Chemical analysis plays a very important part in the manufacture of iron, Bessemer and Siemens steels, and even of the comparatively small quantity of crucible cast steel which is still used for purposes in connection with which it is not required to be hardened and tempered. It is possible to judge very accurately of the quality of those metals from their chemical analysis, almost as much so as from the results of mechanical tests, such as the breaking strain and the contraction of the area of fracture. But in what we may call, for want of a better name, the legitimate cast steel trade, chemical analysis, though it tells us a great deal, does not tell us everything. The analysis of steel shows the amount of other ingredients which it contains besides the nine-tenths or more of iron which forms its basis. The amount of carbon, silicon, manganese, sulphur, phosphorus, copper, &c., may be ascertained with tolerable accuracy, and the information thus obtained is often of the utmost importance; but it is quite possible to make a comparatively low-priced steel which shall show precisely the same chemical analysis as the best crucible cast steel; nevertheless it is found by practical experience to be inferior in quality. That this is a fact has been proved over and over again beyond all possibility of doubt. It is a sufficient reason why Sheffield manufacturers have been willing to pay such a high price for Dannemora iron for so many years; but it is not a sufficient reason why so many Sheffield manufacturers should ignore the results of chemical analysis altogether. Of every fact there must be some explanation, though we may, for the present at least, be ignorant of it. To say, with the Sheffield devotees of the rule of thumb, that the one steel possesses "body," and that the other does not, explains nothing, but merely adds to the synonymy of the subject by altering the nomenclature. If the metallurgical chemists could once convince themselves that this difference in quality is a fact, they would probably soon be able to give us an explanation. We already know much of the chemistry of steel, and what remains to be learnt is as certain to be some day discovered as the fact that Newton discovered the laws of gravitation. Mathematicians may never discover how to square the circle; mechanics will never discover a perpetual motion, nor will chemists ever discover the transmutation of metals; but the discovery of the chemical explanation of "body" is only a question of time. By way of stimulating inquiry, I venture to suggest two possible causes of body which may be worth consideration as a tentative hypothesis of its nature. The best razor steel contains one and a-half per cent. of carbon. It must be melted from evenly converted steel. It will not do to mix hard and soft steel together, or to melt it from pig "let down" with iron; though in either case the exact one and a-half per cent. of carbon may be the result. Steel made by the latter processes will not possess the requisite amount of body; consequently the cutting edge of the razor will not stand. It must be melted from steel converted from iron made from ore containing manganese. It will not do to add the manganese in the form of spiegeleisen or ferromanganese. Carbon and manganese exist in combination with iron, not chemically combined in certain definite proportions, but as alloys, as mechanical mixtures in any proportion. We know that carbon exists in combination with iron in two forms, either as combined carbon or free carbon; is it not possible that manganese may also exist in two forms? and though the razor steel must have been boiled in the pot for half an hour after it was melted, to kill it and make the ingot pipe, is it not possible that the mechanical mixture of the carbon and the manganese is less homogeneous in steel made by the cheap processes than it is by that made by the old-fashioned method? It has been stated that the finest qualities of steel when hardened show a more perfect regularity in their crystallisation when examined under a microscope than commoner qualities, and I venture to suggest that a possible explanation of "body" in steel may be absence of injurious ingredients, combined with the perfectly homogenous presence of the advantageous ingredients. Hardened steel is crystallised steel; and that perfect regularity of crystallisation in steel which is required to be ground to a fine cutting edge may be a necessity which can only be secured by the slow and expensive old-fashioned method. The principal reason why Bessemer and Siemens steel have failed so completely to supersede crucible cast steel for purposes where the better qualities are required, is that they cannot be made sound without the addition of silicon or manganese. In melting common steel—containing, for example, from 0·15 to 0·05 per cent. of phosphorus—the steel must be poured into the mould as soon after it has become perfectly fluid as possible, and as hot as the tensile strength of the pot will allow. In making the higher qualities of crucible cast steel—where the percentage of phosphorus ranges from 0·01 to 0·001—a similar mode of treatment would produce very strange results; the molten steel would boil over in the mould, the fracture of the ingot when cold would show a series of bubbles like a sponge, and its specific gravity would scarcely exceed that of wood. Some of these bubbles or honeycombs would weld up when the ingot came to be forged, but by far the greater number would be coated with an oxide which would make a weld impossible, and the bar, if it was not burnt up in the fire, would be so full of the imperfections technically called "seams" or "roaks," as to be perfectly useless. To obviate this disastrous result, it is necessary to boil the steel for nearly half an hour after it has become fluid, and then to allow it to cool down to a certain temperature before it is poured into the mould. This process is called in the language of the votaries of the rule of thumb, "killing" the steel, and it is an axiom amongst them that the higher the quality of the steel the more "killing" it takes. It is in this part of the process of crucible cast steel melting that its special virtue consists, and the cost and quality of the cast steel produced depend in a large degree upon the skill brought to bear upon it. There is an old proverb in Sheffield, usually expressed in the terse vernacular of the country, but which may be refined into the expression that if you put his Satanic majesty into the crucible his Satanic majesty will come out of the crucible. The converse of this is by no means the case. Though you may convert iron into steel in the crucible, you cannot convert bad steel into good steel in the crucible; but though you may put the most angelically pure steel into the pot, you may, by bad management, by not "killing" it properly, pervert it into Satanically bad ingots. Now this "killing" of the steel is precisely what cannot be done in the Bessemer or Siemens processes without the addition of such a large amount of manganese or silicon that the steel becomes brittle when hardened. I do not know whether chemists are agreed on an explanation of the necessity for "killing" high-class steel. When iron is made into steel in a converting furnace, it is assumed that the oxygen in the air in the converting pot unites with the charcoal, and is soon made into carbonic acid, which is occluded by the white-hot iron, and forced by it to part with as much carbon as is sufficient to reduce it to carbonic oxide. It has been ascertained that metals have the power of absorbing or occluding many times their own bulk of gas, and possibly the carbonic acid, when it has parted with the amount of carbon necessary to reduce it to carbonic oxide, is not then expelled from the iron, but may remain in an occluded state, and requires to be expelled in the melting pot by boiling. Be this as it may, it is a fact that if it be required to make blister steel harder than about 1·4 per cent. of carbon, it is necessary to convert it twice over, possibly in order that in the interval it may part with some of its occluded carbonic acid, so as to make room for a further occlusion of carbonic oxide. Another fact which may throw some light upon this question, is, that blister steel melted directly after being drawn from the converting furnace requires more "killing" than that which has been exposed to the air for some time, during which it has presumably had an opportunity of parting with some of its occluded gas. The addition of a portion of scrap steel materially assists the process of "killing," as would naturally be the case if we suppose that the scrap—which has been melted before—has parted with its occluded gas in the first melting. The fact that the presence of manganese or silicon helps largely to kill the steel may possibly be accounted for on the theory that the carbonic acid unites with the manganese or silicon and becomes a solid, or it may be that in an alloy of iron with either manganese, silicon, or phosphorus, the occluded gas is expelled at a much higher temperature than in pure iron. Before describing the process of making crucible cast steel it may be useful to devote a few words to the nomenclature of iron and steel. This is almost as much a vexed question as that of zoological nomenclature, and might form the subject of a code of laws, which would probably be as complete a failure as those issued under the auspices of the British Association for the Advancement of Science, which have made confusion in the scientific names of birds and beasts worse confounded. In Sheffield we attempt to discriminate between iron and steel, which we regard as generally distinct, and each of which we subdivide specifically, though it must be admitted that neither our generic nor specific names are very scientific. Pig iron is melted direct from the ore in a blast furnace, and contains from 3 to 5 per cent. of carbon. When re-melted it is called "cast iron" or "metal." Spiegel iron is precisely the same, but contains in addition from 5 to 15 per cent. of manganese. Bar iron, often called wrought iron, is pig iron which has been smelted and deprived of nearly all of its carbon, either in a puddling furnace or by the Walloon, Lancashire, or other analogous process; the spongy mass or ball of iron is usually hammered or rolled into a bar, which for the Sheffield trade is generally 3in. wide, $\frac{5}{8}$in. thick, and from 6ft. to 12ft. long. Puddled steel is precisely the same as "bar iron," except that the process of puddling is stopped when rather more than half of the carbon has been removed from the pig iron. There is consequently no hard and fast line between bar iron and puddled steel, the one intergrading to the other by imperceptible degrees. Although there are an infinite number of intermediate stages between the softest bar iron and the hardest puddled steel, and although it is impossible to state the exact percentage of carbon which marks the dividing line between one and the other, it is usual to call all puddled bars which cannot be hardened in water bar iron, and all those which can, puddled steel. This dividing line falls somewhere near a mixture containing a-half per cent. of carbon, and although it looks very vague and unscientific to use two terms which thus intergrade, no confusion of any kind, or misunderstanding, has ever been known to arise from their use. Blister steel is bar iron which has been converted into steel in a converting furnace, and varies in the amount of carbon which it contains from $\frac{1}{2}$ to $1\frac{1}{2}$ per cent. There are, of course, an infinite number of degrees of carbonisation between "hard heats" and "mild heats," but for the convenience of the trade six of them have been selected, and have received names as follows:—No. 1, spring heat, $\frac{1}{2}$ per cent. of carbon; No. 2. country heat, $\frac{5}{8}$ per cent. of carbon; No. 3, single-shear heat, $\frac{3}{4}$ per cent. of carbon; No. 4, double-shear heat, 1 per cent. of carbon; No. 5, steel-through heat, $1\frac{1}{4}$ per cent. of carbon; No. 6, melting heat, $1\frac{1}{2}$ per cent. of carbon. Bar steel is blister steel which has been tilted or rolled down to the size required. Single-shear steel is produced by welding half-a-dozen bars of blister steel together. Only those bars are chosen in which the process of conversion has been so far carried on that the outside of the bar is steel and the centre of the bar, iron. When these are welded together, and tilted or rolled down to a small dimension, the result produced is a mechanical mixture of iron and steel, a material which combines great tenacity with the capability of carrying a moderately hard cutting edge, and is much employed for certain kinds of knives. Double-shear steel is produced by drawing down single-shear to suitable-sized bars, and re-welding two of them together, so that the mixture of iron and steel may be more perfect. Cast steel is steel that has been melted in a "pot"—called a crucible in the encyclopædias—and poured into a "mould"—called a "form" in the learned books—thus becoming an "ingot," which is afterwards hammered or rolled to the size required. It may be made of various "tempers," varying in the percentage of carbon which they contain from three-quarters or less to one and a-half or more. The different tempers may be arrived at in various ways. For the great majority of purposes there can be no doubt that the best way is to put into the melting pot broken pieces of blister steel converted exactly to the temper required; and the more evenly the steel is converted, and the more carefully all bars which are harder or softer than the temper required, or which are "flushed" or "aired," are rejected the better. Blister steel, when carefully "taken up" or selected, will produce a cast steel which combines the greatest amount of hardness with the maximum amount of elasticity when hardened. It may, however, happen that for certain purposes "soundness" in the bar, the result of absence of "honeycombs" in the ingot, may be the most important quality required in the steel; for others, the property of welding most perfectly may be the *sine qua non;* or the great evil to be avoided may be the tendency to water-crack in hardening; or the steel may be used for some purpose where it does not require to be hardened, and the object to be secured is the combination of the greatest amount of hardness and toughness when unhardened. In all cases the mode of manufacture must be adapted to the objects which it is most important to secure. In addition to the mode of operations already mentioned, there are two other ways in which the same percentage of carbon may be secured. You may either put cut bar iron into the pot, and "fetch it up" to the required temper with charcoal, or you may put broken pig iron into the pot, and "let it down" to the required temper with cut bar iron. A fourth *modus operandi*, which for most purposes is the best of all, might be enumerated, namely, the selection of blister steel slightly harder than the temper required, so as to admit of being slightly let down to the exact temper by the addition of a small quantity of somewhat milder cast steel scrap. Bessemer steel and Siemens steel do not require definition, nor do they come within the scope of this paper.

(*To be continued.*)

* Iron and Steel Institute.

London Water Supply.—The Lambeth Waterworks Company is now issuing notice to its water consumers in the large district lying between Brixton-road, from Kennington Church down to Camberwell-green, thence southward along the centre of High-street, Camberwell, to Coldharbour-lane, and along the centre of Coldharbour-lane to the junction with the Brixton-road and thence northward along the centre of the Brixton-road to Kennington Church, that it is intended to change the intermittent for the constant supply, and the owners and occupiers are required to change their fittings to the new supply system before the commencement of next year. The company gives notice that under Parliamentary authority the connections with the company's mains is to be done by the company's workmen, and that the company is to be paid in advance for the costs and charges incident to making the connection. Moreover, no fittings are to be altered without two days' notice to the company, a requirement which will give owners and occupiers within the district a considerable amount of difficulty in getting the work done.

Metallurgy and Fuel Lectures at King's College, London.—We learn that the subject of the evening lectures, in connection with the Metallurgical Department of the college, under Professor A. K. Huntington's superintendence, will be for the ensuing session, "The Properties of Metals and Alloys, and their Uses in the Arts," and that special attention will be devoted to the metallurgical requirements of the City and Guilds of London Institute examinations in metal plate work, plumbing, and iron and steel. These lectures will be delivered on Monday evenings from eight to nine, commencing on the 6th October. On the same evening, from seven to eight, a new course of lectures on "Fuel" will also be given by Mr. W. G. MacMillan, Demonstrator of Metallurgy, which will include the subjects required for the City and Guilds examination in that subject. The laboratory for practical work will be open from seven to nine on Friday evenings, as in previous years; it is also open, as usual, every day from ten till four—on Saturdays ten to one—for occasional students, as well as for those who are attending the college engineering course. We are informed that the fees for the evening courses are to be reduced.

Race between Two Electric Launches.—A new electric launch, the Australia, has just been completed and launched from the wharf of the Electrical Power Storage Company, at Millwall. The hull of this launch has been built by Messrs. Forrest and Sons to the order of Messrs. Stephen Smith and Co., engineers, for an Australian firm. She is of mahogany; length, 25ft.; beam, 5ft. 7in.; and she can carry sixteen persons comfortably. The motive-power consists of a number of electrical power storage accumulators placed as ballast on the bottom of the boat, and a Reckenzaun electro-motor driving a two-bladed gun-metal screw of 18in. diameter and 12in. pitch. The Reckenzaun motor weighs 390 lb., and is capable of working up to 6-horse power mechanical, but ordinarily it will be worked at a lower rate—in this boat at the rate of 5 electrical horse-power. A competitive trial trip took place on Saturday, the 19th instant, from Millwall to Charing-cross pier and back to Greenwich, the competing launch being the well-known boat Electricity, which caused some sensation when launched in September, 1882. This launch was designed at the time by Mr. Reckenzaun for the Storage Company. She is of iron, 25ft. long, and only 5ft. beam. A set of electrical power storage accumulators supply the current to a Siemens D_2 dynamo weighing 658 lb. The screw is of steel, made by Messrs. Yarrow and Co., 18in. diameter and 11in. pitch, and which screw formed a pattern for casting the one in the new launch. It was arranged that during the trial both machines were supplied with the same amount of energy, viz., 3730 watts, or 5 electrical horse-power, the new boat being the winner.

The Successes and Tragic End of a Genius.—The career of M. Volkmar, the banker and speculator of Paris, who committed suicide in that city on July 22nd, was in many respects a remarkable one. A gentleman of New York who was connected with the Faure Electric Storage Company, in speaking of the late financier, said to a *Telegram* reporter to-day:—"It is true that Volkmar began as a workman in M. Faure's electrical factory in Paris. While there he studied the Faure patent for the storing of electricity, which was a leaden plate immersed in a chemical bath, and he conceived the idea of manufacturing the accumulator on his own account. Leaving M. Faure's employment he went to England, where in 1882 he endeavoured to get a patent for a so-called improvement of the Faure apparatus, his improvement consisting merely of a perforated plate instead of a solid one. The British Patent-office, however, refused to grant letters patent on so small an improvement, and besides, there was doubt as to whether the additional surface gained by the perforation was a new idea. Notwithstanding his failure to obtain a patent, he formed a partnership with Mr. Sellon in the same year, and they began manufacturing the Volkmar-Sellon improved plate. They did well, and I imagine that Volkmar took out of the enterprise 500,000 dols. Then his partners, disliking his methods of business, offered him a small sum to withdraw from the firm or threatened to force him out. He took the small sum and went to Paris. The possession of so much money troubled him, so he consulted with M. Philipart, the most famous speculator who has appeared in Europe since George Law's day. Philipart gave him some points, and he speculated on the Paris Bourse. On the whole he was fortunate in this venture, and soon acquired a reputation for great strategic powers. Volkmar was active until his death, but lately he suffered so many severe losses that he became despondent. Volkmar's methods were peculiar, and his reputation for cunning caused him to be viewed with suspicion. He never failed to get into difficulties with all his *confrères*, except Philipart, with whom he did not dare to trifle. His is a remarkable life. Beginning without trade or profession, then becoming an electrician, appropriating his employer's ideas and making a vast fortune on them in a foreign country. A speculator, first successful and then a loser, and finally dying by his own hand. His system of storage is in general use even now in England and the United States." The body of Volkmar, formerly a resident of this city, was found in the Seine on the 22nd ult., with a bullet through his head and his pockets rifled. He is supposed to have been murdered, and his own pistol was found in his house. The affair created a great sensation in the French capital. He visited New York in 1881.—*Scientific American*.

RAILWAY MATTERS.

MR. ALEXANDER McDONNELL, M.I.C.E., has resigned his position of locomotive superintendent of the North-Eastern Railway.

A DEPUTATION recently waited on the New South Wales Minister of Works, and urged the desirability of constructing a railway from Narrabri to Walgett, a distance of about 110 miles.

THE Bulgarian Government has appointed a Commission to inquire into the question of the purchase by the State of the Varna Rustchuk Railway. Among the Commissioners is a former Minister, M. Jelescovitch.

WE have received a copy of the second edition of the handy little pocket-book of the "Universal Tables for Ranging Railway Curves, applicable to Metres, Feet, or Gunter's Chain," by Mr. J. L. Galliott, M.I.C.E., and published by Messrs. H. Sotheran and Co.

THE Arlberg Railway from Innsbruck to Bregenz, on the Lake of Constance, was formally inaugurated on Saturday by the Emperor Francis Joseph. This gives France a road into Italy without using German lines. The new route will save a distance of about ninety miles between Paris and Belgrade, for Salonica, Constantinople, and the East.

A PASSENGER train on the Indiana and Western Railroad was thrown off the rails in Illinois on the 17th ult. by a broken rail. The coaches were badly wrecked, and fifteen persons were wounded. The Democratic candidate for the Vice-Presidency, Mr. Hendricks, was in a coach which rolled 20ft. down an embankment, turning upside down. He is, however, still the candidate.

THE Minister for Public Works of New South Wales has given instructions to the Engineer-in-chief for Harbours and Rivers to confer with the Engineer-in-chief for Railways, as to the best mode of connecting Sydney with the north shore by a bridge. At despatch of recent mail, the same Minister had under his notice tenders for duplicating the railway line from Parramatta to Penrith.

NOW that the juncture of the Metropolitan and Metropolitan District Railway is approaching completion, the *Builder* remarks that it is a proper time to call attention to the want of a connection between the Great Western and Metropolitan Railways at Paddington—a connection, we mean, by which passengers may be able to pass from one station to another without climbing steps, and having to cross a crowded thoroughfare. Such a connection has now for some years been in existence between the Great Eastern and the Metropolitan Railways.

MAJOR-GENERAL HUTCHINSON, R.E., on behalf of the Board of Trade inspected the Inner Circle Railway and its extensions connecting it with the East London Railway at Whitechapel on the 8th inst., and subject to certain small requirements being completed to his satisfaction by Saturday evening next, he stated that he would recommend the Board of Trade to sanction the opening of the railways for public traffic. The Metropolitan and District Companies are now perfecting the working arrangements, so that the new line can be thrown open to public use on Wednesday, the 1st of October.

AMONGST the items of the Prussian Budget for 1884-85, the new State purchases of railways figure rather prominently; and it may be noted that the new lines taken over by the State since the 1st of January, 1884, are as follows:—(1) The Upper Silesian line; (2) Breslau-Schweidnitz-Freiburg line; (3) The Right Bank of the Oder line; (4) The Altona-Kiel line; (5) The Pozen-Creuzberg line, and the Schaumburg-Lippe portion of the Hanover-Minden Railway. In the case of the first four lines, the State has confined itself for the present, as on the occasion of former purchases, to taking over the administrative receipts and working of the lines, and the guarantees and obligations of the companies from January last, but the shares and debentures will be gradually called in and exchanged for Government Stock of the 4 per cent. Consols. The extent of the new lines is described as embracing a length of 3698·72 kilom., thus bringing up the total extent of Prussian State railways to 18,924·43 kilom., and leaving 1700 kilom. of Prussian railway still in the hands of private companies.

THE *Railroad Gazette* record of train accidents in July contains brief accounts of thirty-six collisions, forty-six derailments, and seven other accidents, a total of eighty-nine accidents, in which twenty-five persons were killed and 142 injured. As compared with July, 1883, there was a decrease of thirty accidents, of thirty-two in the number killed and of sixty-two in that injured. These accidents may be classed as to their nature and causes as follows:—Collisions: Rear, 25; butting, 10; crossing, 1; total, 36. Derailments: Broken bridge, 5; spreading of rail, 6; broken wheel, 1; broken axle, 2; broken truck, 2; accidental obstruction, 2; cattle on track, 4; land slide, 2; washout, 1; runaway engine, 1; misplaced switch, 4; rail purposely removed, 1; unexplained, 15; total, 46. Other accidents: Boiler explosions, 3; broken coupling rod, 1; accidental obstruction not causing derailment, 2; explosion of dynamite, 1; total, 7; full total, 89. Four collisions were caused by trains breaking in two, four by misplaced switches, two by the wrecking of other trains, one each by fog, by a runaway engine, by failure to use signals, by mistakes in giving or receiving orders, and by a car left standing on the train track.

SINCE 1880 and to the end of 1883, Poor's "Railway Manual" says, 28,405 miles of railroad have been built in the United States. The cost, as represented by share, capital, and debt, was about 70,000 dols. per mile, while Messrs. Poor state that the actual cost did certainly not exceed 30,000 dols. per mile, and they add that the whole increase of share capital during that period, nearly one thousand millions of dollars, and a portion of the funded debt besides, was in excess of cost of construction. The *Engineering and Mining Journal*, commenting on this, says:—Assuming that the actual cost of construction was not greater than the funded and floating debt, and some that is certainly water, the average net earnings of the railroads of the United States are about 9 per cent. Apparently in 1883, it was 4·49 per cent., so that one half of the entire nominal liabilities of the railroads of the country upon which they are expected to pay a fair return is simply and purely fictitious. For every dollar actually invested two are set afloat on paper. How onerous a burden upon the agriculture, the commerce, the manufacturing and mining interests of this country this enormous amount of fictitious capital must be may well be imagined.

A CORRESPONDENT writing with reference to our recent article on "An Indo-European Railway," says:—"The whole line, from London to Bombay, has been calculated to extend over a distance of under 7000 miles, and this distance can be traversed in nine days at the rate of 35 miles per hour. The surveys of the line have been committed to the care of a well-known and distinguished French engineer. And he has been joined in the undertaking by competent English engineers. All of these feel confident that the undertaking will be attended with every success. That section of the line which extends from Tangiers to Cairo can be constructed in three years, while several parts of the same section will be open for working in two years' time. The whole line, from Tangiers to Bombay, Calcutta, and Madras, will be open for traffic in five years' time at maximum. No adequate idea can be given of the incalculable commercial advantages likely to be reaped by merchants and traders in this country, as well as in other European countries, from the working of the Indo-European line. It has been proposed to start a special mail train from London to Bombay every two days. This train will call at the principal stations only, will carry—light—Parcels Post, and will take first-class passengers only. An express train will start every day, carrying passengers, local mails, heavy Parcels Post, and other goods and articles of value. Other trains will start from London, such as will ensure the advantageous employment of every part of the line. The total receipts for the whole line, including those derived from carriage of passengers, mails, Parcels Post, goods, luggage, &c., have been estimated and promise to yield a large revenue in return for capital invested."

NOTES AND MEMORANDA.

ONE of the most attractive objects at the Nice Exhibition is said to be a Chinese clock which is only stated to date back to eight hundred years before the birth of Christ.

THE Guion mail steamer Alaska has made another splendid passage, namely, 7 days 2 minutes. She left Queenstown at 9.20 a.m., Sunday, September 14th, and arrived at New York at 5 a.m., Sunday, September 21st.

THE International Conference to fix a prime meridian meets in Washington on October 1st. Arrangements are now being made for the sessions in the State Department. Almost every country of Europe and America will send representatives.

THE largest organ in the world has just been completed by Walck of Ludwigsburgh, and placed in the cathedral Church of Riga. The colossal instrument measures 36ft. in width, 32ft. from back to front, and 65ft. high. It contains no less than 6826 pipes, distributed among 124 sounding-stops.

THE deaths registered last week in twenty-eight great towns of England and Wales corresponded to an annual rate of 21·4 per 1000 of their aggregate population, which is estimated at 8,762,354 persons in the middle of this year. The six healthiest places were Brighton, Plymouth, Derby, Birkenhead, London, and Portsmouth. The rate at Brighton per 1000 was as low as 9·2.

IN London 2604 births and 1373 deaths were registered last week. The annual death-rate from all causes, which in the four preceding weeks had steadily declined from 21·2 to 19·9 per 1000, further fell last week to 17·8. During the past eleven weeks of the current quarter the death-rate averaged 21·7 per 1000, against 21·1, 18·5, and 19·2 in the corresponding periods of 1881, 1882, and 1883.

IN 1858 the quantity of copper raised in New South Wales was 58 tons, valued at £578. In the following year the quantity sank to 30 tons. Since then, with the exception of two or three years, there has been a steady annual increase, until in 1883 the quantity reached 8957 tons 7 cwt., valued at £577,201. The total quantity raised during the period 1858-83 was 61,051 tons 17½ cwt., valued at £4,115,486.

THE topaz has, it is said, frequently been met with in New South Wales; a portion of a large bluish-green-coloured crystal, found at Mudgee, and now in a colonial museum, weighing several pounds, and others weighing several ounces are by no means rare. They are sometimes 2in. to 3in. long, and broad in proportion, especially those from Uralla. One found at Gundagai, of a pale blue-green tint, measured 3in. by 1½in., with a weight of 11 oz. 5 dwt. Another of a similar colour from Gulgong weighed 18 oz. avoirdupois. Unfortunately, it had been broken into two pieces. The pale bluish-green tint is the most common colour. Sometimes they are slightly yellow.

DURING the week ending August 23rd, 1884, in thirty-one cities of the United States, having an aggregate population of 7,332,800, there died 3474 persons, which is equivalent to an annual death-rate of 24·6 per 1000, an increase of 1·6 over that of the previous week. The deaths under five years of age were 48·9 per cent. of the total mortality, the percentage being highest in the Lake cities—viz., 58·4 per cent. The *American Sanitary Engineer* says:—"The rate in the North Atlantic cities was 24·8; in the Eastern cities, 25·2; in the Lake cities, 24·0; in the River cities, 21·8; and in the Southern cities, for the whites 23·7, and for the coloured 34·7 per 1000."

THE latest census taken in Roumania gives the number of inhabitants at 4,424,961, of whom 2,276,558 are males and 2,148,403 females. Classified according to their religious creeds, there are 4,198,664 Orthodox Greeks, 134,168 Israelites, 45,152 Roman Catholics, 28,903 Protestants, 8734 Gregorians, 8108 Armenians, and 1323 Mahomedans. The foreign element in the population, apart from the Israelites, consists of 28,128 Austrians, 9525 Greeks, 3658 Germans, 2822 English, 2706 Russians, 2631 Turks, 1142 French, 167 Italians, and 539 of divers nationalities, making in all 51,417. The urban population is only 781,170, as against 3,643,783 in the country.

IN an article on horses in *The English Illustrated Magazine*, it is remarked that "probably the quickest time on record is that made by the late Lord Stamford's Diophantus, a son of Orlando, who through Eclipse and other horses united the great Arab strains. Diophantus won the Two Thousand Guineas in 1 min. 43 sec. The course is 17 yards over one mile; and this time, over the same course, was equalled by Galopin, winner of the Derby in 1875, in his match against Stray Shot, dam of Shotover, who won the great Epsom race for the Duke of Westminster in 1882." The speed given is equal to 35·236 miles per hour, a speed which we believe has been beaten.

THE platinum diggings of Russia are near Bogoslowsk, Miask, Newjansk, and Nischnei Tagilsk, in the Ural Mountains. They were discovered in 1824; and at six places—in 1868, 1869, and 1870—from 494,000, 367,000, and 263,000 tons of sand, 6675, 7770, and 6455 lb. of raw platinum were obtained respectively. The metal contains always some other substances; thus Le Play found, in a sample from Nischnei Tagilsk, 75·1 platinum, 1·1 palladium, 3·5 rhodium, 2·6 iridium, ·6 osmiridium, 2·3 osmium, ·4 gold, 1 copper, and 8·1 iron. The raw metal is almost entirely sold to England and Paris, at a price of about £14 per lb. of pure metal. It is there refined before it can be worked up into manufactured articles.

AS the benefit accruing from the covering of water pipes with felt in recesses in the outside walls of buildings has been questioned, when the pipes are subjected to a long attack of cold with no circulation of the water, except that which can go on within the pipes themselves, the American *Sanitary Engineer* cites an experiment of Mr. Rossman's—of the firm of Mead and Rossman—which goes far, it says, to prove the value of this comparatively inexpensive precaution. "Some few years since the question was mooted, when the gentleman above named, to prove the matter to his own satisfaction, caused three similar bottles to be filled with water and placed in the area during a severe cold season. One bottle was uncovered, one had thick brown paper pasted on it, and one was covered with a thickness of ¾in. of hair felt sewed on. The uncovered one burst the first day; the one with the brown paper one burst on the third day; and the one covered with felt remained uninjured until the cold spell had passed. From this the gentleman reasoned that, while theoretically correct, so long as the water can receive no addition of heat, it will freeze through felt if exposed for a sufficiently long time; that our periods of cold sufficient to freeze the water pipes of a house are not sufficiently long in this latitude if ordinary precaution is taken with felt."

THE use of aluminium in the arts has been much restricted by difficulty of soldering it, either to itself or other metals. A French engineer, M. Bourbouze, has overcome this. The process consists in plating both surfaces to be soldered, not with pure tin, but alloys of tin and zinc, or, what is better, tin, bismuth and aluminium, &c. Good results are obtained with all such alloys, but those containing tin and aluminium are best. They should contain different proportions, according to the work the soldered parts have to do. For parts to be fashioned after soldering, the alloy should be composed of 45 parts of tin and 10 of aluminium, as it is sufficiently malleable to resist the hammer. Pieces thus united can also be turned. Parts which have not to be worked after being soldered may be united with a soft solder of tin containing less aluminium. This last solder can be applied with a hot soldering iron, as in soldering white iron, or even with a flame. Neither of these solders requires any prior preparation of the pieces to be soldered. It suffices to apply the solder, and extend it by help of the iron over the parts to be joined. When, however, it is desired to solder certain metals with aluminium, it is best to plate the part of the metals to be soldered with pure tin. It is sufficient then to apply to the part the aluminium plated with alloy, and to finish the operation in the usual manner.

MISCELLANEA.

AT the International Forestry Exhibition, Edinburgh, Messrs. Robey and Co. have been awarded the highest award, a gold medal, for engines and machinery.

THE Cambria Ironworks, the largest Pennsylvania iron company, have reduced wages 10 to 20 per cent. from October the 1st. The cause is depressed trade.

THE chief offices of the English and Scottish Boiler Insurance Company, Limited, in Manchester, have been removed to larger premises at 58, Fountain-street.

HER Majesty's Gunboat Wasp sunk suddenly off Tory Island, Donegal Coast, on Monday afternoon, only five out of fifty-eight crew being saved. Satisfactory accounts as to cause are not yet forthcoming.

ON Saturday last Messrs. Oswald, Mordaunt, and Co. launched a fine iron sailing ship of 1500 tons register and of the following dimensions:—Length, extreme, 351ft., breadth 38ft. 3in., depth of hold 32ft. 9½in.

A VERY interesting and useful pamphlet of eighty pages, entitled, "Gas Burners, Old and New," by Owen Merriman, has been published by Mr. Walter King. It contains a historical and descriptive account of the progress of invention in gas burning, and contains an account of the theory of luminous combustion.

A DESPATCH, dated the 19th inst., from Panama, sates that the final contract for cutting the last section of 30,000,000 cubic metres of the canal has been signed between the canal company and the New York Dredging Company, a firm of American contractors, the price being 1f. 45c. per metre. The work will be finished by 1887.

A NEW law for the protection of trade marks has been promulgated in Servia. By the Anglo-Servian treaty of commerce, 7th February, 1880, Article 9, British subjects are entitled to rights in relation to trade marks similar to those enjoyed by natives of Servia. Servia is also one of the signatories of the International Convention for the protection of Industrial Property, 20th March, 1883. In order to obtain the benefit of the new law the owner of a trade mark should deposit three copies of the mark at the Belgrade Court of Commerce, within one year from the 19th July, 1884.

MR. G. H. STAYTON, who has for nine and a-half years so well filled the position of surveyor of Chelsea, has resigned that appointment, and intends leaving England for Australia before winter. It is well known that during Mr. Stayton's period of office the most important works ever carried out in Chelsea have been designed and completed by him. These include several miles of new sewers, increase in streets from 26 to 35 miles, and 5½ miles new streets and courts, improvements in street lighting, the establishment of extensive wharves and plant, and many other marked improvements. His reports on electric lighting are widely known. His resignation has been received with much regret by the vestry.

ON the 23rd inst. Mr. G. Skelton launched at Millwall, a smart little steam yacht, the "Daisy," which has been built for Messrs. James McEwan and Co., of London, for their colonial trade at Fiji. She immediately afterwards ran a very successful trial trip. The yacht is 35ft. long by 7ft. beam, and constructed of Siemens steel, with rounded steel gunwales and steel turtle back forward. A galvanised iron fresh-water tank is fitted amidships to feed boiler, and a trimming tank in the bows. The engines are of the inverted direct-acting high-pressure type, 4in. diameter of cylinder, by 5in. stroke mounted on steel columns. Boiler of steel, with brass tubes. Both boiler and engines were constructed by Messrs J. J. Seekings and Co., Gloucester. The yacht is also fitted with two masts and a full suit of sails.

A CONFERENCE was held on Monday between the provisional committee of the Manchester Ship Canal and the Mayor of Manchester and parliamentary sub-committee of the Corporation, with a view to arrive at an agreement by which the Corporation should subscribe a sum equal to a rate of 2d. in the pound, and become co-promoters of the Canal Bill. It is now proposed to carry the canal along the Cheshire side to the Mersey from Runcorn to the deep sea, and it was stated that although this scheme would be rather more costly than the first proposal, it would have the advantage of providing a deep-water way from the first lock to a point opposite Warrington without a single intervening obstacle. It is now proposed to take the Manchester racecourse for docks. The Mayor decided to call a public meeting of the ratepayers to take a vote on this matter.

ON the 20th inst. a double-ended quadruplex propeller steamship, the Snowdrop, was launched from the yard of Messrs. Allsup and Sons, at Preston. This vessel is the second of two sister ferry boats, building to the order of the Wallasey Local Board, from the designs of their engineers, Messrs. Flannery and Fawcus, of Liverpool. The draught of water being limited, it is not possible to obtain the immersion of sufficiently large screw propellers of an ordinary type, and therefore the system of having four screw propellers, viz., two at the bow and two at the stern, has been resorted to. The vessels are 130ft. long and 35ft. wide, and present an extremely large deck surface for the accommodation of passengers. They have engines working at 100 lb. steam pressure, the highest pressure yet used on the Mersey. It is expected that they will steam about 12½ miles an hour. They are built of steel, and will be fitted with the electric light.

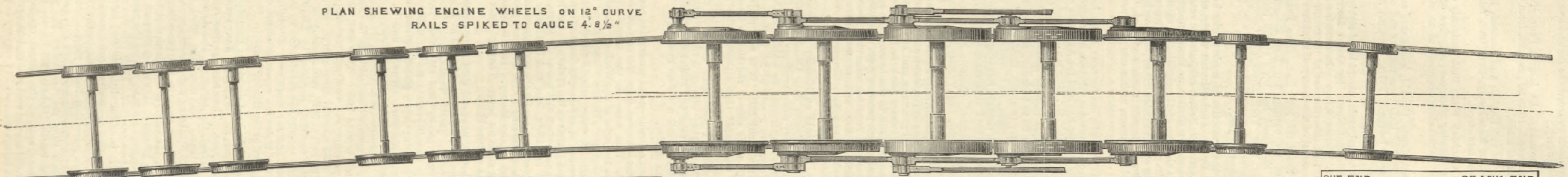
ON the 23rd inst., a powerful steel twin-screw salvage tug, the Bulldog, was launched from the shipyard of Messrs. E. Finch and Co., Chepstow, for the Bristol Docks Committee. The principal dimensions are 92ft. length over all, 20ft. breadth, 10ft. depth moulded. She is specially fitted for salvage purposes, being supplied with a 5-ton swing crane placed amidships, a steam-driven capstan and winch combined forward, and an 18in. centrifugal pump placed just aft amidships, and strong towing gear at end of boiler casing. The crew are berthed in after part of vessel under deck. Complete chequered iron deck runs fore and aft, and barlow rail belting entirely around hull. Two steel boilers, designed for 120 lb. working pressure, and two pairs of compound surface condensing engines of 30 nominal horse-power each, will be fitted by the builders. The hull is built considerably in excess of Lloyd's requirements, the scantling required by Lloyd's for the 100 A1 class in iron being throughout substituted by steel of same thicknesses. The boat and her machinery throughout has been built from the design and under the superintendence of Mr. John Ward Girdlestone, engineer to the Bristol Docks.

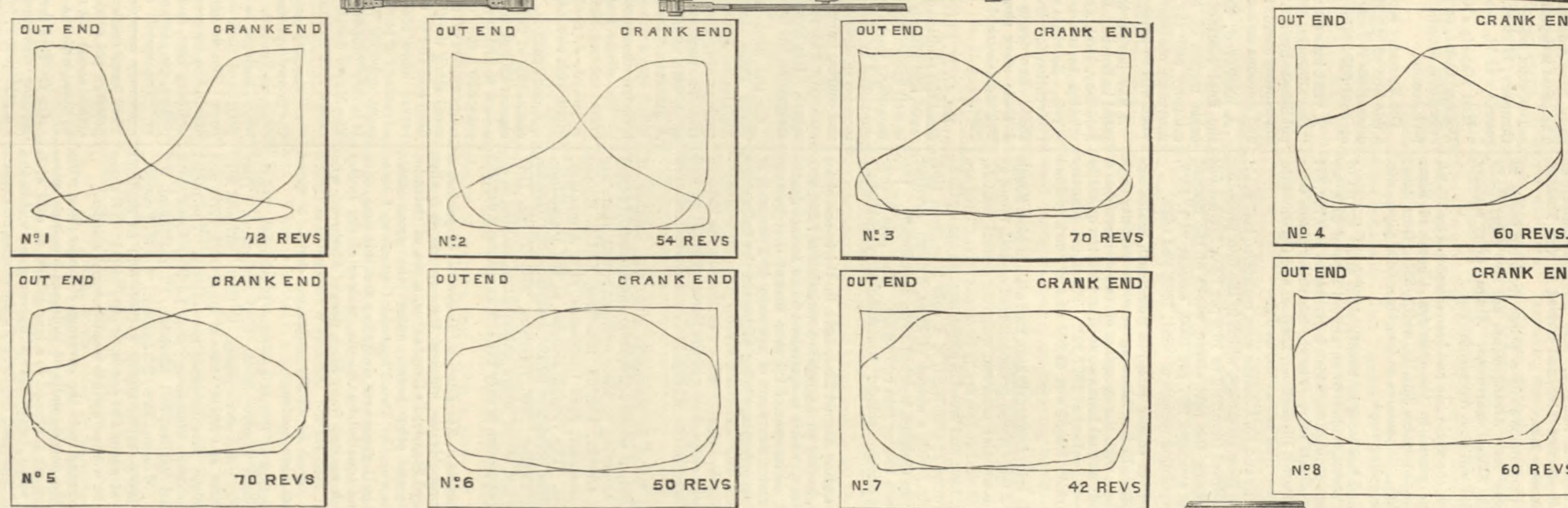
THE coal mines in the Nord district of France produced 3,789,000 tons of coal last year, an increase of 3 per cent. on the quantity for the preceding year. That amount was raised by seven coal companies, the largest, the owner of the Anzim Collieries, producing 2,182,000 tons. To raise the total 19,880 men were employed, about 15,510 being underground men. As the number of workmen were fewer than in the preceding year, and as the yield was more in the total, it is evident that the average output of the miners was greater. It was for the past year 244 tons per man. The annual wage per man was on the average 1086·21f. per man, not £45 per man per year. Even this was above that for the preceding year. It is added that the coal cost on the average 5·69f. per ton, and that the realised price was also on the average 11·26f. per ton. The important facts in the return are that the French miners are increasing their yield of coal, and that the individual pits are increasing more, but it is needless to add that in both particulars they are far below the yield of our own collieries. In the South Durham district, for instance, says the *Newcastle Chronicle*, each of the miners employed brings out on the average over 380 tons of coal yearly, but in the French district named the miner brings out only 244—a very important difference if true.

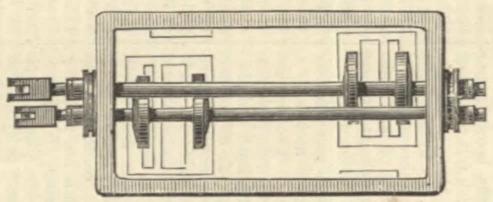
THE CHICAGO RAILWAY EXPOSITION—GOODS LOCOMOTIVE, CENTRAL PACIFIC RAILROAD.

(For description se page 241.

PLAN SHEWING ENGINE WHEELS ON 12° CURVE
RAILS SPIKED TO GAUGE 4' 8½"







PLAN OF STEAM CHEST SHEWING
VALVE SEATS AND STEMS

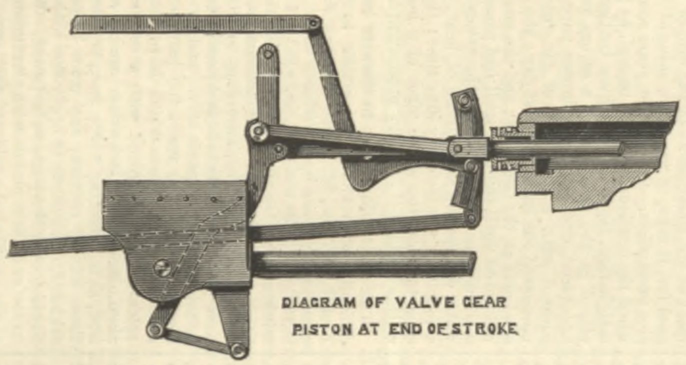
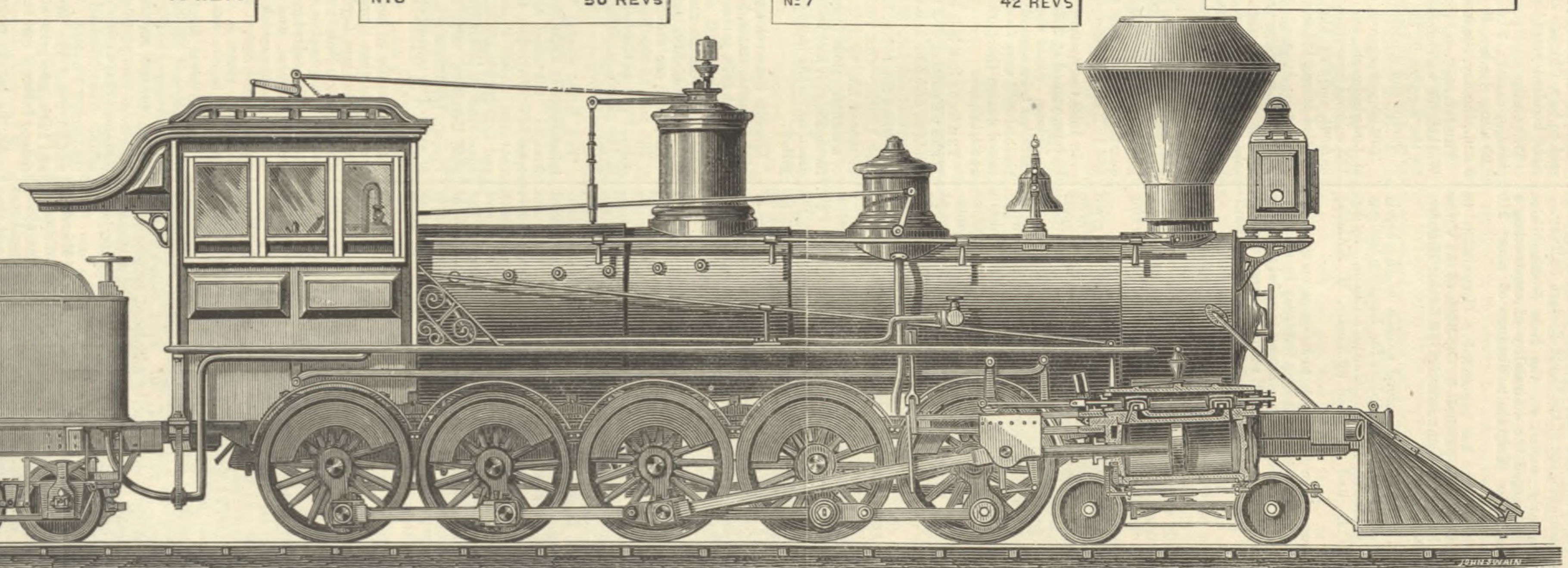
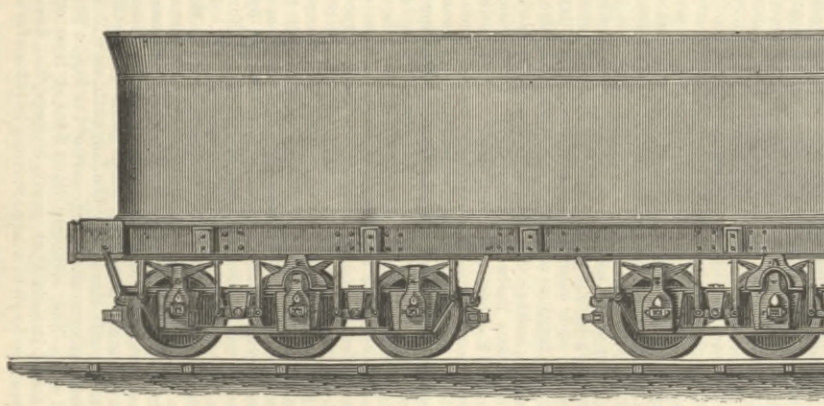


DIAGRAM OF VALVE GEAR
PISTON AT END OF STROKE

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THE ENGINEER.

SEPTEMBER 26, 1884.

THE EXAMINATION OF WATERS.

DR. ANGUS SMITH, while more generally known as the Chief Inspector under the Alkali Acts, was engaged during the last few years of his life in sundry investigations connected with the pollution of water, and in this capacity held the office of an inspector under the Rivers Pollution Prevention Act of 1876. As the result of his inquiries, he presented two reports to the Local Government Board. One of these was issued in May, 1882, and the last a few days ago, its appearance being subsequent to the death of its author. In fact, the demise of this laborious worker and original thinker took place while his last report under the Alkali Act was passing through the press, in which document he made reference to his "protracted illness," which he said could "only be cured by rest." He also made mention of his "lengthened investigation under the Rivers Pollution Prevention Act," the report of which he described as being already in type. It is fortunate that this was the case, for otherwise we might have lost the fruits of a painstaking and important inquiry. This zealous servant of the public was remarkable not merely for the positive results which he achieved, but for the suggestions which he threw out; and he has done much to moderate the extravagant notions to which at times there has been a tendency among scientists in dealing with sanitary questions. We will acknowledge that there is something rather perplexing in the report which has just been issued, and there are passages which might be cited by the ultra-purists in support of their doctrines. At one time we find the judicious investigator himself startled at the phenomena which he had conjured up. Thus, when declaring that the Thames waters showed distinct inferiority to the hill waters, he says: "As I feel deeply the responsibility of publishing these results, I was at first not inclined to give the names of the different water companies from which the specimens were taken." But he goes on to say, "The results of examination of sewage and sewage rivers, the decomposition of nitrates, and the escape of free nitrogen, the wonderful effects of putrefaction in destroying living organisms, the marvellous power of oxidation in finishing the process, and the complete disappearance of diseases, or what we may call the germs of disease, after the fountain head is left, abundantly prove that nature has taken care that curative and purifying influences shall be rapid and exist almost everywhere." That the water of the Thames, even after being filtered, is less pure than waters of the uplands of England, is described as a truth that "can hardly be called new." But the claim is made that the difference "can be subjected to measurement, and put into the form of figures so far as certain qualities are concerned." Could the effect on health be measured with equal certainty, the gauge would be still more valuable. But the expert says, "that question I must leave for the present."

In discussing the examination of waters, Dr. Angus Smith speaks of himself as having long been conscious of the imperfect nature of chemical analysis as applied to the question which so often presents itself, "Is this water well fitted for drinking or the preparation of food?" He thus found himself very desirous of obtaining a plan which might be able, by means purely chemical, to give us some idea of the amount of vitality, vegetable or animal, existing in water, when the microscope failed to guide. Mr. Heisch had made use of sugar as a test for water, and was the first to do so. But Dr. Angus Smith appears to have carried the inquiry further, and with marked success. Sugar when put into water produces fermentation, and hydrogen gas is liberated. But we are now shown that the quantity of gas thus produced varies in accordance with the amount of zymotic impurity present in the water. It may be said that this is just what might be expected. But Dr. Angus Smith proceeds to take another step, asserting that his process measures "the amount of organic activity amongst the microbes—at least of a certain class—which exist in the waters." Boiled water yields no hydrogen, neither does water that has been obtained by distillation. The question as to the kind of microbes producing the decomposition, receives the answer that "they are such as, if in large numbers, render water impure to the senses." But are these microbes such as produce disease? Or are they composed of two classes, one hurtful, and the other not so? The idea presented to us is, that the hydrogen is a measure of the presence and activity of microbes that are capable of producing disease, though there is a distinct admission that organisms may not be in all cases unwholesome. That the hydrogen test is really a measure of hurtful activity is thought to be more or less proved by the fact that the amount of hydrogen is in direct proportion to the quantity of sewage mingled with the water. Admitting that the argument is in the nature of a speculation, we are urged to look upon it as one which gives us some hope of advance in this department of knowledge. It is suggested that in sewage we have, at some stage or other, the germs of every disease existing in the community, and perhaps, if intensified to a certain point, "the germs of every possible disease." If, indeed, we now possess a means of calculating the force developed by microbes, we shall be able to calculate the electrolytic power of the movements involved in the life of a single organism, and hence determine its mechanical equivalent. This seems a rather far fetched speculation. All depends on the certainty that the measurement of zymotic action by the evolution of hydrogen may be taken as a measure of the germs of disease. It is clearly a point gained, and one possessing great practical importance, if we can bring these disease germs, so to speak, "to book." Dr. Koch claims to have found the germ of cholera, and Dr. Angus Smith has apparently discovered or perfected a method by which the germs can be made to indicate their presence and afford a measure of their force, even when undetected by the microscope. Still, we do not quite understand or perceive that harmless organisms are not mixed up with those that are injurious, so that the former help to swell the aggregate of hydrogen. If all the microzymes are disease-producing creatures, so much the worse for mankind. Dr. Angus Smith tries to soften down the feeling of alarm which his researches may have a tendency to create, by suggesting that some organisms may be of an innocent nature. Thus he says: "These bacteria found in the waters which we examined are not germs of disease necessarily; we are drinking them constantly."

The manner in which air interferes with zymotic action is an interesting and important part of this subject. Dr. Angus Smith cites some experiments conducted in Paris on the sewage of that city, showing that when air is blown into "sewage water," the properties and composition of the liquid are rapidly modified. "The water saturated with air is no longer liable to putrefaction." In order to prove this, we are told, we may take a stoppered bottle filled with ordinary sewage water, and a beaker filled from the same source, the contents of the beaker being aërated. At the end of twenty days or less, the sewage water in the bottle will have become "black and infected," while that in the beaker "is still clear and inodorous after two months." This description is hardly so full and precise as could be wished; but of the fact which it is intended to prove there need be no doubt. But putrefaction has its value, as destructive to germ life. Oxidation completes the process, and the germs are thus destroyed. This aids the doctrine of the self-purifying power of rivers. Dr. Angus Smith did not arrive at the conclusion that the Thames afforded London a drinking supply that was altogether pure. Despite the natural processes calculated to destroy the germs of disease, that is to say the living organisms present in the water, he considered that most of the rivers in the vicinity of large towns contained impurity in excess of the purifying influence. That some of the organisms should escape with their lives down the valley of the Thames was not to be wondered at or doubted. On this point we would observe that a great many microzymes are likely to mingle with the water of the Thames below Barking, and to go a long way before being broken up and oxidised. But London, though decidedly a "large town," does not pollute its own water supply. The pollution of that supply must be from localities higher up the stream. That this pollution is extremely minute, and is so destroyed by aeration and filtration as to be practically eliminated, is affirmed by some of the most eminent chemists of the day. Dr. Angus Smith tested the London supply both by the hydrogen method and by the gelatine process of Dr. Koch. The results may be taken as showing the relative value of different waters, as, for instance, that the Manchester water is superior to the London supply, or that one London company supplies better water than another. But there is no proof that the London water is other than wholesome. How it can be bad is difficult to understand, in view of the teaching as to the self-purifying power of rivers, and remembering also the care that is taken to keep offensive matters out of the Thames above Teddington Lock. One curious fact is that the London waters of February 15th, 1883, when mixed with 80 per cent. of distilled water, gave results similar to those obtained with London water alone. Had the London waters been bad, such a large admixture of distilled water must have ameliorated their condition. In April last year, sundry waters were examined by the gelatine test, when the sample of the West Middlesex supply was pronounced "one of the best of the series." This was in comparison with the Manchester water, and the water of Loch Katrine, as well as sundry metropolitan supplies. We do not observe that in any instance the water of the Kent Company was put to the test.

The action of gelatine on water, according to the process devised by Dr. Koch, is to give an "expansion" to the living germs. That is to say, it cultivates them. The water to be tested is mixed with a due proportion of gelatine, and is exposed to observation in a glass tube. The condition is noted daily for several days. The most objectionable manifestation is when the surface of the gelatine becomes liquid. The depth to which this extends is taken as a measure of the sewage pollution. In the experiments conducted during several days in April, 1883, we find that the Lambeth, Grand Junction, Chelsea, West Middlesex, and Southwark and Vauxhall samples maintained a firm surface of gelatine. There were other indications—as there were also in the Manchester and Loch Katrine waters—such as would betray the presence of living organisms; but what might be the quality of these creatures is not quite evident, and Dr. Angus Smith acknowledged that the point was undetermined. Questions were thus raised which he confessed he was unable to answer; neither did he hope to solve the problem except after a long period of sedulous investigation. "The exact physiological effect" corresponding to the latter class of indications thus remained a mystery, and the scientist, after all his labours, was content to own that he was giving the public only a "minimum of information." It is to be hoped that those who may pursue the inquiry will be as modest and cautious as the earnest expert who has just passed away, and will not omit the every day proofs of the potable value of Thames water.

THE MAXIM MACHINE GUN.

AT this stage in the development of machine gun fire no new design is likely to meet with much attention unless there is something very striking and promising in it. The machine guns already in use have been so far perfected in their working that nothing now entering the field is likely to overtake them and compete successfully with them on their own lines. To hope for success or, we might almost say, to hope for much opportunity of competition, an inventor must put forward fundamental advantages in principle such as can be shown sufficient to promise very decided superiority over the guns that have already found their way into existing armaments, and which will not readily be displaced. On this ground, and nothing less, must a machine gun, now brought forward by Mr. Maxim, to be seen at 57D, Hatton-garden, stand. Our readers can judge for themselves of the probability of the principles embodied in it proving successful in practice. As to their originality and ingenuity in conception, we think there cannot be two opinions.

In machine guns hitherto tried, the feeding and firing and the traversing have to be performed by manual power, and, however beautifully carried out, the operator in any competition for speed is pretty severely tried; and one operator alone can hardly manipulate the machine at high speed, and in his breathless condition alter its direction to any purpose. Of course, the assistance of another man must be had when the particular magazine from which the rounds are entering the gun is exhausted.

Mr. Maxim, therefore, in his machine claims to have achieved a remarkable advance in making the recoil of his barrels work the feeding and firing gear; the operator kneels down quietly behind the breech and directs the barrel at his leisure exactly as he likes. There are clearly more advantages in this than appear at once. First, as noticed above, the heavy work of manipulation is saved; secondly, the danger of a jamb from a delay or hang fire is obviated, for the obvious reason that as it is the shock of discharge of each round that loads and fires the succeeding one, when a cartridge hangs fire, the gun must wait for it, as without it there is no motive power to load the next round. This is clearly a very different condition of things from that in other machine guns, when a man is driving the loading and firing gear as hard as his strength permits, and when a jamb may be produced by delay; thirdly, a much greater rate of firing may be attained than by hand-driven gear, viz., 600 rounds per minute, instead of about 200; fourthly, the machine may be much lighter, and need not be clamped rigidly, as must be the case when a lever handle has to be violently worked on one side of it.

The gun may be described as follows:—It has a single barrel, arranged in such a way as to recoil slightly in its bearings, the force of recoil of each round acting on the feeding and firing gear, so as to load and discharge the next round, and so on, round after round in succession. That is, the force of recoil extracts and ejects the empty case, brings the next round into position, pushes it home, and cocks and liberates the striker. The barrel recoils $\frac{9}{16}$in., with its breech held firmly closed. This gives the bullet time to escape, and fly about 100ft., so that the gases have also abundant time to escape after it has left the muzzle. Then a locking hook, which has held it close, is opened, and the barrel is stopped, while the breech and extractor run on, carrying the empty case with them. This is ejected, and the succeeding round brought into position by a feed wheel, when the return stroke, given by a connecting rod, sends the charge home, closing the breech, pushing the barrel forward into the firing position, and finally releasing the striker which fires the round. The recoil of this round repeats the above movements, and so on, as long as filled cartridges are supplied and fired. Mr. Maxim has made his gun with a 0·45in. bore to fire the service cartridges. He has a pattern of cartridge case which enables him to have a much simpler gun, because he is able to dispense with the recoil of the barrel proper and work with the breech recoil alone; but Mr. Maxim thinks it wiser to sacrifice what is necessary to enable him to meet all existing conditions. The gun without stand weighs about 60 lb., a tripod stand for a man-of-war about 130 lb., and a carriage for field service from about 60 lb. to 200 lb., according to the requirements of the case. This tripod is about 3ft. high, and the piece from muzzle to rear of firing mechanism measures about 4ft. 9in. The gun can be left to move freely by hand for rapid change of position, as in the case of torpedo boats or cavalry at short distances; or it may be clamped and traversed or elevated by slow or quick movement screws. The cartridges are fed either from a belt or a drum. The belt is preferred by many; General Sir G. Graham, R.E., we believe, for one. Each band or belt is about 7ft. long, and carries 333 cartridges, and one belt can be joined on to another, so that a stream of indefinite length can be used with care and attention in placing the boxes containing each belt in position. The drum fits on to the top, and is, we think, a more ordinary and less complete arrangement; it only holds 96 cartridges, also, and a man would be much more likely to be exposed in changing drums than in arranging the belts, and he would be kept constantly employed; in fact, one man does not appear to be at all sufficient for the work in rapid firing. When at full speed—600 per minute—allowing the bullets a velocity of 1200ft. per second, it will be seen that a stream of bullets is formed, 150ft. from bullet to bullet. Should all men near the piece be killed, the gun will go on firing as long as the supply of ammunition lasts. Under these conditions, the barrel must become very violently heated. Some of our readers are perhaps familiar with the spectacle of machine gun barrels firing at a much lower rate of speed passing through the different tempering colours of steel. Mr. Maxim endeavours to provide for this by enclosing the barrel in an outer gun-metal case, which allows a large space between barrel and case to be filled with water. Finally, he has devised a plan for carrying the smoke off from the muzzle.

The natural objections that appear to suggest themselves are—(1) that the opening of the breech by recoil is difficult to manage safely at so great a rate. We think, however, if it is clearly understood that the breech must remain completely closed—indeed, no more opening than any breech-loading cannon during recoil—until it has reached a point when the bullet is 100ft. away, it will be seen that there is no danger of escape of gas. We should be rather curious to see what would happen if a bullet lodged in the bore; but this is an awkward contingency for any machine gun. (2) It may be objected that a miss-fire stops the firing for the moment, while in many machine guns it merely involves the failure of one bullet, the cartridge being ejected and the firing going on without interruption. We are sorry to say that this very obvious objection did not occur to us while inspecting the gun, so we have not given Mr. Maxim an opportunity of answering it. Perhaps the machine can be sent on by hand instantly; but we think cartridges for this gun ought to be as free from miss-fires as possible, as the loss of a number of rounds delivered in quick firing must be serious.

Altogether, we think the gun a wonderful design, and one which naturally attracts much greater interest than almost any piece in the same stage of development. The speed of firing, the ease of working, and saving of exposure of men promise great practical advantages, and the extreme neatness of the idea of the automatic system, by which each round fires itself and works the gear at exactly the speed that suits its own behaviour, is very attractive. We hope shortly to give illustrations of the working parts.

GAS ENGINES.

THE extensive employment of motors of from ½-horse power and upwards to about 8-horse-power, has made the modern gas engine a very popular machine. From a scientific point of view it is interesting, as involving in the theory of its action some disputed points, more especially with reference to the combustion of the gaseous charge, and the way in which this is affected by the mode of admission of gas and air. One of the most protracted of recent patent infringement cases was that of Otto *v.* Linford, a case which was carried to the Court of Appeal by the plaintiff. The case was first heard before Vice-Chancellor Sir James Bacon, who decided against the plaintiff on the ground of want of novelty, as reported at length in THE ENGINEER of August 1st, 1881. In the Court of Appeal, it was heard before the Master of the Rolls and Lords Justices Brett and Holker, as reported in our impression for the 3rd February, 1882. The decision of Vice-Chancellor Bacon was here reversed.

As an important part of the history of the gas engine, these cases were of very great interest, and will continue to be so for some time. The Otto gas engine was admitted to be a great stride upon all gas engines that had preceded it, and all the theoretical and practical points of importance in the construction of the engine were fully set forth by the different witnesses on each side, and were put before the world with remarkable clearness in the decisions of both courts. The theory put forward to explain the results obtained in the Otto engine, and the form of indicator diagram obtained, was that the engine was so arranged in its parts that a charge of incombustible gas or atmospheric air was first admitted to the cylinder, that a combustible charge of mixed air and gas were subsequently admitted, that these two charges did not completely mix before ignition took place because they had not time to do so, and that in consequence of this arrangement and action of the charges, the air acted as a cushion and absorbent of heat, the effect being a more gradual combustion and gradually decreasing pressure, giving an extended expansion curve and securing greater duty from the gas used. Days were occupied in the discussion of this question of the arrangement of the charges, with arguments for and against more or less complete diffusion of the gas throughout the combined charges. Men of high reputation gave it as their opinion that the two charges remained practically distinct, while men of equal ability disputed this. The compression of the charge, which was a feature of the Otto engine, was not urged as a novelty, except in the first stages of the trial. A gradual explosion, or combustion rather than explosion, was claimed as the effect of the arrangement of the two charges, and this, it was urged, gained the higher economy which marked the Otto engine as a result of lower temperature and less loss of heat conveyed through the walls of the cylinder to the water jacket.

In reviewing the evidence the Master of the Rolls said the Court "had only two claims in Otto's specification to deal with, namely, claim No. 1, for admitting the combustible mixture with air separate from a charge of air or incombustible gas;" and claim No. 2, for "compressing by one instroke of the piston a charge of combustible and incombustible fluid drawn into the cylinder by its previous out-stroke, so that the compressed charge when ignited propels the piston during the next out-stroke, and the products after combustion are expelled by the next instroke of the piston, substantially as herein described." The Master of the Rolls added, "the compression was old, but Otto claims the combination of compression with his system of introducing air and this combustible mixture so as to make, as he says, a gradual explosion or increase of power."

The trial had thus shown that compression might be generally used; and further, that so long as the whole cylinder charge was mixed before entrance to the cylinder they could, of course, be used, and more than this, that the compression of such a mixture might be used.

In commenting upon the whole case in our impression of the 3rd February, 1882, and with a view to the possible further development of gas engines and their manufacture, we were led to ask whether such a combination might not be useful. As remarked by a correspondent in our impression of the 10th of February, 1882, the indicator diagram obtained from the Lenoir engine did not differ materially in the character of its expansion curve from that obtained from the Otto engine; and experience in several ways indicated that the gradual expansion curve was not due to features wholly wanting in the earlier engines, and the indicators used were themselves not wholly blameless for the imperfect character of the diagrams from these. Recent experience seems to be answering in a most positive way our question as to the possibilities of the use of a previously mixed charge and a certain amount of compression. There seems to be no doubt that its use may be wholly successful, and no doubt it will ultimately lead to very great improvement in the capabilities of gas engines, and to their very extensive use. Diagrams we have lately seen from an engine made by Mr. J. E. H. Andrews prove this, and show an expansion curve comparable in its steadiness with that of a good steam engine, although it is quite evident that the combustion took place entirely within the first ninth of the stroke. The fact that such a curve is not only obtainable, but is actually the curve produced by an engine which may be seen running at any time, removes all possible doubt as to the stratification hypothesis, and therefore takes away all room for opinion on the matter. That the stratified cushioning did take place as asserted was never satisfactorily proved or disproved, but the evidence of practical proof that a long expansion curve is equally obtainable with a homogeneous mixture previously made, now establishes the fact that even if it does obtain in the Otto engine is not necessary to the same results in another engine.

There is little doubt that compression judiciously carried out, and with proper relations between the capacity of the part of the cylinder swept through by the piston and that part only used as a charge holder, has a great deal to do with the gas engine success; but good as are the results obtained, there is yet a field of possible improvement in the duty of this motor which is vastly greater than in the case of the steam engine.

OUR COAL EXPORTS.

IN the decline in quantity and value of the exports from this country which is general in several trades, it is to be noticed that the coal trade has no part. Last year showed the largest coal export, but this year there are indications that the quantity for the past year will be exceeded. For the first eight months of the past year the exports of coal were 15,029,000 tons, whilst for the same time this year the exports were 15,648,000 tons, and the quantity shipped for the use of steamers engaged in the foreign trade was 50,000 tons more than in the first eight months of last year, so that the exports and the consumption in our foreign going vessels was 700,000 tons more in the first eight months than it was a year ago. It is satisfactory to notice, too, that the increase in the exports is spread over a very wide area, the only falling off this year being in the shipments to France and to Holland, though it is probable that to Italy we shall send less this month, and probably also to Spain. The losses from these southern countries, it is hoped, will be temporary only, and that returning health would increase the demand cannot be doubted. One of the causes of the large export of coals is, unquestionably, the lowness of the rates of freight, and there are no signs of any great change in this respect, so that there may be hoped continued large export. We have more competition to meet in some of the markets that we supply, it is true, but low freights and the comparatively low price of coal should enable us to meet it, and to obtain as large a share of the orders for coal, which are being continually increased. The same causes should enable us to open out other markets which need coal, and which we could supply. Our great ocean fleet is increasingly a steam-impelled one, and the power ought to be supplied by our own coal in a larger number of cases than it is, for whilst steamers obtain their supplies of best steam coal in the Tyne for less than 9s., and at Cardiff for a little over, they have abroad to pay from 30s. to 38s. at some of the coaling stations, so that it would pay in some cases to take more than is taken from our own markets.

THE LOSS OF VESSELS.

THE dispute that took place recently between the Board of Trade—or the officials of the Board—and the shipowners, has been of value in one way—it has directed attention to the manner in which vessels are lost. We have in the official registry for the past month a few facts which have an interest as bearing very directly on that question. From the register of shipping for both the United Kingdom and the Colonies there were removed 119 vessels of all kinds. Out of that number there were 24 sold foreign, or a fifth of the total. Out of the remainder 25 were wrecked, 17 were stranded, 10 were "lost," 17 were broken up, 3 were removed owing to collisions, 2 were "missing," 7 foundered, 4 were burnt, 1 was abandoned, and the remainder were removed for "other causes." It is evident on looking at that list, and at the summary of the causes of removal which we have quoted, that there is a very large proportion of the vessels lost for which no blame can be assigned to the owners in regard to the loss. The vessels sold, stranded, broken up, and in collision, form more than half of the total, and blame cannot be assigned in these cases to the owners, and probably the same remark might apply to the number wrecked and burnt, so that we have at once three-fourths of the loss in which the responsibility is removed from the owners; a state of affairs which is certainly not in keeping with the declamations to which we have of late been treated. If this official document is studied, it will be found that there is increased and increasing need for the improvement, not so much of the laws of insurance, as of the practice of seamanship.

ECONOMY IN STEEL MANUFACTURE.

FOLLOWING the progress by which science has enabled succeeding generations to live by utilising the manufacturing refuse of the processes of those who have gone before them, the basic steel maker of to-day should benefit by the ironmaking of yesterday. Such is the opinion of Mr. Richard Smith-Casson set forth at the Social Science Congress this week at Birmingham. Nor is it easily seen why the suggestion should not develope into one of the most important branches of the utilisation of waste products. Of cinder from the puddling furnace capable of being utilised in the Bessemer basic process, there is, it is stated, more than 1,000,000 tons in Staffordshire alone containing some 50 per cent. of iron. Whether the cinder as at present made in the Bessemer basic converter will be left as a legacy to future generations, or whether the efforts now being made to turn it to profitable account will meet with success, has yet to be determined. Mr. Smith-Casson, however, points out that since writing the paper, Professor Thomas Egerton, of the School of Mines, New York, has written him that in a small town near Essen the basic Bessemer slag is worked up into phosphate of lime, used for agricultural purposes, and the residue left capable of being used with profit in the blast furnace for making basic pig. The works and plant are very simple, but the proprietors assert that they are making a handsome profit.

LITERATURE.

A Treatise on Ore Deposits. By J. ARTHUR PHILLIPS, F.R.S. 8vo., pp. 651. London: Macmillan and Co. 1884.

ALTHOUGH numerous detailed memoirs upon mineral deposits have appeared at different times in English technical journals, besides larger works dealing with the ores of particular districts, such as the late Mr. W. J. Henwood's volumes of "Observations on our Western Mines," Mr. Wallace's "Alston Moor," &c., the want of a general work dealing with the subject accurately, but without excessive detail, has long been felt; and this want will, for the majority of readers, be supplied by the volume now under consideration. The author, as is well known, is a mining engineer of large and varied experience, which becomes apparent in the relatively large amount of space devoted to the newer developments of minerals in America and Spain, when compared to the older districts in Western Europe.

The work is divided into two parts—the first devoted to a general description and classification of the phenomena of ore deposits, which are illustrated in the second by examples collected from different mining regions in all parts of the world, classified geographically. The importance of the different localities is illustrated in the only way that is usefully possible, namely, by ample statistical detail, the returns extending for several years; so that the progress or retrogression of any particular locality is readily seen. Departing from the practice usually adopted in similar works, the author omits all preliminary matter of a mineralogical character, the reader being supposed to bring a preliminary knowledge of the nature and properties of the minerals useful as ores. The classification adopted is of the following character:—Superficial deposits: Mechanical placers, stream works; Chemical, bog and lake ores. Stratified deposits: nodular iron ores; crystalline iron ore, magnetic hematite ores; Ore-bearing sediments, Mansfeld and Commern. Unstratified deposits: True veins, segregated veins, gash veins, impregnatures, stockworks, fahlbands, contact deposits, chambers or pockets.

As regards the origin of mineral lodes, the author, after passing in review the different theories of igneous injection, deposit from above, sublimation, lateral secretion and deposit from below, notices the late work of Sandberger and others on the presence of determinable quantities of metallic minerals in the rocks of metalliferous districts, and arrives at the conclusion that lodes may often have been produced by lateral secretion, without the intervention of a higher heat than that of the local atmospheres, and that these minerals may have been deposited from solutions at points not far removed from their original position. The action of heated water, whether due to central or volcanic heat, would, of course, be proportionately more efficacious. It is interesting to find that an observer of such wide experience as the author adopts this view, once unfashionable, but now coming into general acceptance.

The second, or descriptive part, necessarily contains much information that has already appeared elsewhere, but in all cases references to the original authorities are given, and collectively the notices give the facts connected with the more important mines of the world in as compendious a form as possible. This part might have been improved by the addition of short generalised sketches of each country as a whole, preceding the detailed description, as the names of famous mines, even when well-known to the initiated, do not of themselves convey much information to beginners without some kind of indication of their positions. Apart from this, however, the work is a very valuable one, and likely to prove of great service to mining men of all kinds. The illustrations are well executed from drawings that have been made with an amount of care not usual in this class of figures, and are of a very effective character.

BOOKS RECEIVED.

Gas Burners; Old and New. By "Owen Merriman." London: W. King. 1884.

Applied Mechanics; an Elementary General Introduction to the Theory of the Structure of Machines. By James H. Cotterill, F.R.S. London: Macmillan and Co. 1884.

Transactions of the Institution of Naval Architects. Vol. xxv. Edited by G. Holmes, Secretary. London: The Institution, and H. Sotheron and Co. 1884.

Text-book of Descriptive Mineralogy. By Hilary Bauerman, F.G.S. London: Longmans, Green, and Co. 1884.

A Practical Treatise on the Manufacture of Bricks, Tiles, Terra Cotta, &c. By Charles Thomas Davis. London: Sampson Low and Co. Philadelphia: H. Carey Baird and Co. 1884.

Transactions of the Institution of Civil Engineers of Ireland. Vol. xiv. Dublin: The Institution. 1884.

A Treatise on Practical and Theoretical Mine Ventilation. By E. B. Wilson. London: Trübner and Co. New York: J. Wiley and Sons. 1884.

A Treatise on Ore Deposits. By J. A. Phillips, F.R.S., M.I.C.E. London: Macmillan and Co. 1884.

Field Implements and Machines: a Practical Treatise on the Varieties now in Use, with Principles and Details of Construction. By John Scott. Weale's Series. London: Lockwood and Co. 1884.

COMPOUND SEMI-FIXED ENGINE.

On page 231 we illustrate a compound semi-fixed engine by Messrs. Robey and Co., the general design of which is that now so well known as the "Robey" engine, introduced by this firm in the year 1874.

Experience has shown that a compound engine is not necessarily more economical than an ordinary one, and in not a few cases where they are incorrectly made and used, the low-pressure cylinder acts as a brake upon the high-pressure, and thus a loss instead of a gain is the result. In working out the details of the engine illustrated, care has been taken that the best effect should be attained, and the result of using a high pressure with a receiver which is drawn upon by the low-pressure cylinder, as though it were a boiler, is a very high measure of economy. Steam is introduced in the small cylinder at 120 lb. pressure, and by a suitable arrangement of valve gear it is exhausted from the high pressure at about 40 lb. per square inch, is expanded nine times, and discharged from the large one at atmospheric pressure. The exhaust from the large cylinder being discharged at atmospheric pressure only, there is no artificial draught in the chimney; but the consumption of steam is so low that with the ordinary chimney draught a full supply of steam is easily obtained. Both cylinders are jacketted with steam direct from the boiler, and the exhaust from the small cylinder being reheated in a receiver of large capacity, there is scarcely any loss of pressure between the two, the cut-off being so arranged as to equalise the pressure on both cranks. The crank shaft is of extra large diameter, and provided with bearings having horizontal and vertical adjustments. The principal dimensions of the engine illustrated are as follows:—

Diameter of high-pressure cylinder	8½in.
Diameter of low-pressure cylinder	14¾in.
Boiler, double-rivetted in all its seams and tested by hydraulic pressure to 300 lb. per square inch.	
Diameter of barrel	3ft. 4in.
Length of ditto	8ft.
Fire-box shell, width	3ft. 10in.
,, length	3ft. 11in.
Interior of fire-box, width	3ft. 2½in.
,, length	3ft. 3in.
Area for grate	10·4 sq. ft.
Number of tubes	47
Diameter of tubes	2¾
Total heating surface	335 sq. ft.

The result of a large number of experiments made by Messrs. Robey with an engine of the size illustrated showed that they could be easily and economically worked up to 53-horse power with a consumption of only 848 lb. of water and 84 lb. of Welsh coal per hour, corresponding to a duty of 1·6 lb. per horse-power per hour, while experiments extending over several weeks gave a mean result of 1·8 lb. of coal per indicated horse-power—a duty, we believe, unapproached by other engines of the class or size.

Diagrams from the engine exhibited at the Shrewsbury Show, of which we have some specimens, show that the valve gear is well suited to the work, and are of a character suggestive of the high duty obtained.

ELECTRIC MASTHEAD AND SIDE LIGHTS.

Last week an important trial was made, at the instigation of the Admiralty, at Portsmouth, having reference to the practical utility of the electric light for side lights and masthead lights on board her Majesty's ships. The experiments were witnessed by Capt. Carr, H.M.S. Crocodile, Capt. Douglas, H.M.S. Serapis, Capt. Dyer, H.M.S. Sultan, Mr. Marshall, Assistant Constructor, Portsmouth Dockyard, and other naval and dockyard officials, together with Mr. Lane, electrician, Portsmouth, and the Edison and Swan Company's engineer, Mr. J. F. Allbright.

After arranging to place 50-candle power Edison lamps in the ordinary port, starboard, and masthead lanterns of H.M.S. Crocodile, and an ordinary oil light on the South-Eastern Railway jetty, alongside which the Crocodile is lying, as a standard to compare the electric light with, a launch which was used in making the trial proceeded to the St. Vincent training ship, a distance of about a mile, the electric light showing up in a most brilliant manner; and here a signal was made to the Crocodile to substitute 16-candle power Edison lamps for the 50-candle power Edison lamps, the oil lights remaining the same. Naturally the result of this was to diminish the effect, but it enabled a little more careful comparison to be made between the electric light and the oil. When the 50-candle power lights were in, the difference was so great that no fair comparison could be made out; with the 16-candle power lamps in, the electric light appeared approximately to be twice as bright as the oil. The launch then steamed about another mile further off, until she came abreast of the Clarence pier, when owing to a slight haze, the oil light became invisible, while the electric light was still well in sight.

The result of this trial was that the officers and others present expressed their complete satisfaction as far as the illuminating power was concerned, and we believe it is confidently expected that the Admiralty will now generally adopt the use of electric signal lights on board the ships fitted with the necessary plant; and as the prejudice against the use of incandescent lights for signal lights has been, and still is, of a rather determined nature, we trust that this trial made by the Admiralty, and the opinion that they have come to, will materially help in reducing the prejudice alluded to, and that we shall before long see all our large mercantile ships using electric signal lights.

THE CHICAGO RAILWAY EXPOSITION.
No. XV.

Below and on page 230 we give further illustrations of the American palace car, of which we published engravings on page 164. The illustrations now given are Figs. 81 and 82, elevation and plan respectively of the bogies of this fine car, and Fig. 83, an end view of the same bogie. These drawings are especially interesting as showing the construction of the most highly approved form of bogie, with the Master Car Builders' standard sizes of axle and other parts.

In concluding this series of articles on the railway appliances exhibited at Chicago, we regret the unavoidable omission of any notice of many ingenious railway appliances which are novel and interesting to English engineers, most of whom will find in a trip to America much that will amply repay them for the journey. To a young and energetic man with a good knowledge of his business, America offers a field not only for a passing visit, but for a prolonged residence in a rapidly-developing country, where few, if any, branches of the profession are overcrowded.

Among the most noteworthy exhibits were two locomotives, one of which might fairly lay claim to be considered the largest locomotive in the world. We illustrate a similar but still larger engine since built for the same railway.

The gold medal for the best invention, or the best new principle in railway working, was awarded for the engine exhibited by the Philadelphia and Reading Railroad. A very similar engine was illustrated in The Engineer some time ago, and we merely note some special points about an engine which has, since the close of the Exhibition, excited much interest in different parts of the United States.

The engine is built after the designs of Mr. John Wootten, now general manager, and formerly locomotive superintendent of the line. This railway owns a large number of collieries which produce anthracite coal, a fuel which burns with an intense heat, destructive to ordinary fire-bars and fire-boxes. The small coal was formerly regarded as a waste product, but after a long series of experiments a locomotive was devised that would successfully burn this coal, any piece of which will pass through a ring ⅝in. diameter. The grate is of very large size, 68 square feet area, measuring 8ft. wide by 8ft. 6in. long, and the bars are composed of tubes through which water freely circulates. At the end of the grate nearest the tubes is a vertical brick arch or wall, over which the flame passes into a combustion chamber, which measures 2ft. 7in. from the brick wall to the tube plate. The blast pipe can be made of large diameter, and the combustion is far slower and less vivid than in locomotives with the ordinary size of grate. The fire is kept level and about 4in. to 4½in. thick. The method of firing is somewhat peculiar, the firemen scattering each shovelful broadcast over the fire, which is at a dull red heat instead of the white heat usual on a locomotive when working hard.

An engine with a grate of such abnormal area and width must necessarily be of somewhat special design, and, therefore, the grate and part of the ashpan is not only above the frame, as is not uncommon on anthracite burning engines, but is above the driving wheels, the centre of the boiler being raised about 1ft. 11in. above the usual height. As the fire-box occupies nearly as much width as the widest car, the cab cannot be put outside it, and if put behind it the driver could manifestly obtain no proper view of the track. The driver's cab, therefore, is situated in front of the fire-box, and encloses the dome, which is placed nearly on the centre of the boiler barrel. The driver occupies one side of the cab and stands alongside the barrel of the boiler, while the fireman stands on the tender to fire; but as the cab has doors both back and front, he can readily communicate with the driver by walking over the top of the fire-box casing, which is provided with hand rails for the purpose. There are two separate steam gauges, one for driver and one for fireman. The back dampers alone are used; they hinge from the bottom, and when open fall into a horizontal position, and rest on the tender footplate, forming a fall plate between engine and tender.

This description may read strangely to one accustomed to the routine of English practice, but a ride on this engine shows what good results are obtained by means which at first sight appear somewhat fantastic. The engine rides very smoothly and easily, and handles a fast express, a heavy passenger train, or a goods train with equal facility. In trials made on the Chicago, Burlington, and Quincy Railroad, between Chicago and Aurora (I.M.), during the Exposition, the engine exhibited attained a speed of sixty-miles per hour for three consecutive miles, drawing a train of four cars, each weighing about twenty-one English tons. Trials were afterwards made with a passenger train of twelve cars, and freight trains of twenty-five loaded cars. The engine performed her work very satisfactorily, steaming well with small coal, and using either anthracite or inferior bituminous coal, thus fully attaining the object of the inventor.

In Iowa, Dakota, and other North-Western States good coal is very expensive, as it has to be hauled from 500 to 1200 miles, and the coal found on the spot possesses only about 30 per cent. of carbon. The Wootten system of fire-box will apparently be able to burn this coal successfully, and the subject is, therefore, one of considerable importance to these progressive States. The native fuel found in many of our colonies is also very poor in carbon, and produces a large amount of ash, and the difficulty experienced in burning this coal by methods at present in use, should induce colonial engineers to investigate the merits of the Wootten system.

Owing to the draught being spread over so large a fire-grate, even the extremely small coal used will not lift under ordinary circumstances, and the few cinders carried over the brick arch or wall are deposited in the dead angle between it and the tube plate; and are neither lodged in the tube and smoke-box, nor shot out at the chimney top. No spark arrester is really required, but to conform with the law of the State of New Jersey, in which the engine runs, a wire netting with mesh 2½ to the inch is fixed vertically in the smoke-box close to the tubes.

The engine is fitted with steam reversing gear, operated by a single handle, the cocks of the steam and oil cylinders being coupled together. The driver moves the handle until the index shows the gear has reached the position he wishes, when the restoration of the handle to the middle position locks the reversing motion firmly, by closing the communication between the two ends of the oil cylinder. Stops are provided, which prevent the steam piston striking the cylinder ends, should the oil cylinder fail or the driver keep the handle in the forward or backward position too long.

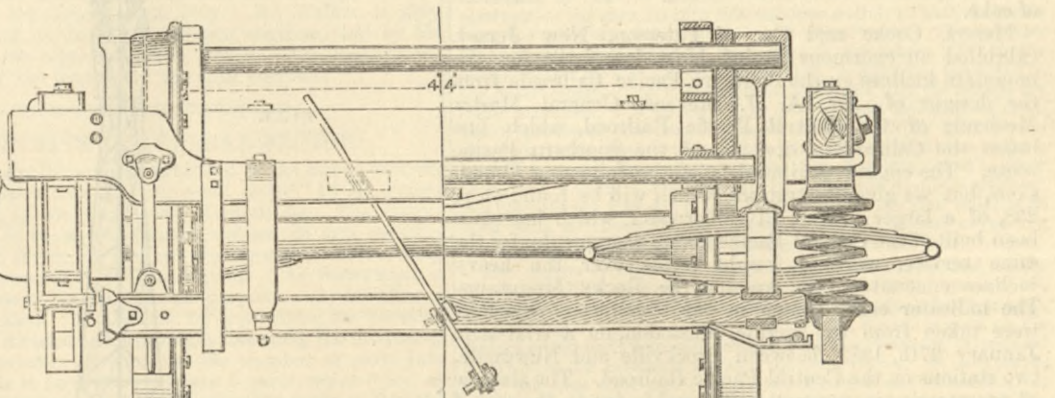


FIG 83

The crosshead and slide blocks are of steel, cast in one piece, phosphor bronze gib-headed rubbing pieces being rivetted to the steel slide block. The solid cast iron crossheads, which were universally used in the States until a few years ago, are now generally superseded by some arrangement similar to that used on this engine, as with the increased size of cylinders, cast iron was found liable to break transversely between the small end pin and the piston-rod socket.

The coupling-rod brasses are tightened by means of a sliding wedge block, through which a screwed bolt is threaded—a form which seems less open to objection than the bolts and straps usual on American coupling-rods.

The engine and tender are fitted with a complete system of water pipes and india-rubber hose for cooling hot bearings. These appliances cost but little, and though they may be seldom required, they enable an engine with a heated bearing to continue her work without delay.

The engine exhibited was built by the Philadelphia and Reading Railroad, at their shops at Reading, Pa., and is of the following dimensions:—

Cylinders	18½in. diameter by 22in. stroke.	
	ft.	in.
Diameter of driving wheels	5	8
Diameter of bogie wheels	2	6
Distance between centres of coupled wheels	6	6
Total wheel base	20	5⅜
Diameter of boiler at smoke-box end	4	5
Diameter of boiler at fire-box end	4	10¾
Length of fire-box, inside	8	6
Width of fire-box, inside	8	0
Length of combustion chamber, inside	2	7
Diameter of chimney	1	6
Diameter of blast pipe, variable from	4in. to 5in. dia.	
Sectional area of tubes, inside	514 sq. in.	
Heating surface—	sq. ft.	
345 iron tubes, 9ft. 2in. long, 1½in. dia., outside	1232	
Combustion chamber	32	
Fire-box	151	
Total heating surface	1415	
Fire-grate area	68	
	Tons	cwt.
Weight on driving wheels	27	3
Total weight in working order	40	1
Tractive force per lb. average pressure per sq. in. on pistons	111 lb.	

The powers of endurance of both American engines aud their drivers is well shown by the fact that this engine ran a passenger train over 850 miles of the Baltimore and Ohio Railroad—a line which is noted for its heavy gradients and sharp curves—in three days, the average day's work being 283 miles. The fuel used was soft bituminous coal; steam was well maintained, and it was found unnecessary to clean the grate bars the comparatively low temperature in the fire-box preventing the formation of clinker, and allowing the ash to fall in the ash pan.

Some observations were made on behalf of the Jury of Awards as to the amount of coal burnt during the experiments on the Chicago, Burlington, and Quincy Railroad. The engine conveyed a train of forty-five empty cattle cars from Chicago to Aurora, the gradients being, on the whole, against the load, and returned with a train of five passenger cars. The weights of the trains were not ascertained, but probably the cattle train weighed about 425 English tons, exclusive of engine and tender. The passenger train would probably weigh about 90 tons. The goods train miles being about thirty-six, and the passenger mileage about thirty-eight, the total train mileage was about seventy-four miles. The total amount of coal burnt was 7980 lb., and deducting half the weight of the useful coke found in the fire-box after the trip—150 lb.—the actual gross consumption of coal was 7905 lb., or 106·8 lb. per mile. Assuming that 50 lb. per mile was burnt in running the passenger train, the consumption in running the goods train would be about 167 lb. per train mile. This very heavy consumption is, no doubt, partly attributable to the inferior quality of the coal, bituminous slack. In the absence of any chemical analysis, or any definite statement of the amount of ash it contained, it is difficult to form any just idea as to the economical use of this fuel in the Wootten engine. No observations whatever were made as to the amount of coal burnt during the trials with waste anthracite. In fact, the subject of coal economy is one that has not yet received its due share of attention in America. The mere fact that an engine will steam satisfactorily, and pull heavy trains, when burning bad coal, is sufficient cause for congratulation, without inquiring too closely as to the amount of coal burnt. It may be added that the bituminous slack evaporated 5·95 lb. of water per lb. of coal. A trial with coke was made, the train consisting of ten cars when running up the prevailing grade, and one special car when returning. The consumption is stated to have been 60 lb. per mile for the round trip; 6·87 lb. of water being evaporated per lb. of coke.

Messrs. Cooke and Co., of Paterson, New Jersey, exhibited an enormous engine, Mastodon, built for the mountain inclines on the Southern Pacific Railroads from the designs of Mr. A. J. Stevens, General Master Mechanic of the Central Pacific Railroad, which line leases the Californian division of the Southern Pacific route. The engine exhibited is of the following dimensions, but we give illustrations, which will be found on p. 238, of a larger engine, El Gobernador, which has since been built at the Central Pacific shops, Sacramento, for the same service, working freight trains over the heavy inclines encountered in crossing the Rocky Mountains. The indicator cards shown in our illustration, page 238, were taken from the engine, Mastodon, on a trial trip, January 27th, 1883, between Brockville and Newcastle, two stations on the Central Pacific Railroad. The absence of compression is very noticeable, and is due to the use of no less than four separate valves for each cylinder, a main valve with riding cut-off valves being provided at each end of the steam chest. A slight inequality in the point of cut-off is due to the expansion of the valve spindle, connecting the two cut-off valves inside the steam chest. The valves having been set correctly in the shop, the expansion of the valve rod moved the front valve, and consequently altered the point of cut-off at the front end of the cylinder. The weight of train on the trial trip was as under:—

20 loaded cars, total weight	377 tons (of 2240 lb.)
Engine and tender	83 „ „
	460
Gradient	1 in 50·3
Radius of curves 8½ chains or	573ft. radius.
Resistance due to gravity	20,480 lb.
Resistance due to friction, say	3,680 lb.
Total resistance...	2,416 lb.
Tractive force per lb. average presssure per square inch in cylinder...	24,160 lb.

It would therefore require about 107 lb. average pressure per square inch in the cylinders to haul the loads at a steady speed. Owing to the late cut-off in full gear an average pressure of 124 lb. per square inch is shown on an indicator card taken at 50 revolutions, or eight miles per hour. The following are the relative dimensions of the two engines:—

	Mastodon.	El Gobernador.
Diameter cylinders	20in.	21in.
Stroke	30in.	36in.
Diameter driving wheels...	4ft. 5in.	4ft. 9in.
Tractive force in lbs. per lbs. average pressure per square inch on pistons	226·4 lb.	278·6 lb.
Number of wheels coupled	8	10
Total number of wheels, E. and T.	20	26
Weight on driving wheels	45 tons 17 cwt.	57 tons 3 cwt.
Weight on truck	9 tons 1 cwt.	8 tons
Total weight of engine	54 tons 18 cwt.	65 tons 3 cwt.
Weight of tender empty...	—	22 tons 12 cwt.
Capacity of tender gallons water ..	2500	3000
Extreme length, engine and tender	64ft.	65ft. 5in.
Diameter boiler...	5ft.	4ft. 9in.
Length of tubes	12.0	12.0
Diameter of tubes	2¼in.	2in.

The valve gear of El Gobernador, which is shown on page 238, is an improvement on that of the Mastadon, inasmuch that only two excentrics are used instead of six, and four valves in all instead of eight. There are four valve spindles in each case, but as the engine has fewer parts and is more than equal in power to two ordinary English goods engines, the complexity is more apparent than real, as the following table shows.

A model of the valve gear of El Gobernador was exhibited, and showed that the distribution given is excellent, the steam port is opened quickly, the valve then remaining almost stationary until the port is closed even more quickly than it was opened. The lead given is very small, and the total amount of opening when working with some degree of expansion is not great; the valve motion is therefore more suitable for heavy freight engines than for express engines running at a high speed, and with considerable expansion.

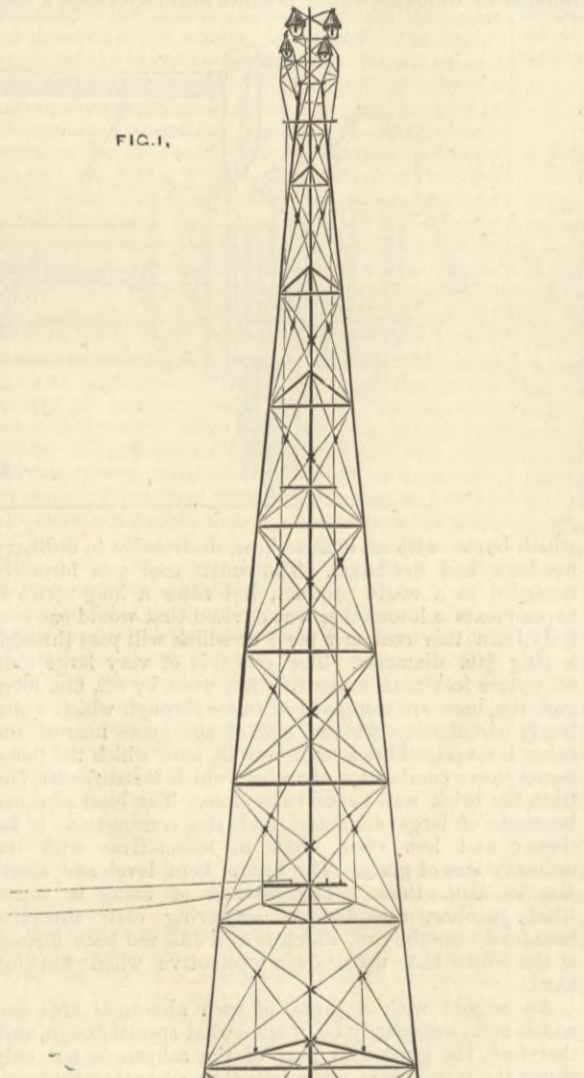
Relative number of parts.	El Gobernador.	Two English goods engines.
Diameter cylinders	21in.	17in.
Stroke	36in.	24in.
Diameter wheels	4ft. 9in.	5ft.
Tractive force per lb., average pressure per sq. in. in cylinder	278·6 lb.	233·6 lb.
Total number of slide valves	4	4
Total number of valve spindles ...	4	4
Total number of excentrics	2	8
Coupling and connecting rod bearings, including coupling rod joints, No.	20	24
Pins in valve motion, No.	25	18 to 36*
Driving wheel axle-boxes, &c., No.	10	12
Carrying wheel axle-boxes, &c., No.	16	12
Springs, No.	24	24

The Mastodon was one of the few engines in the Exhibition which are fitted with bush ends in the coupling rods. The great height of the cab, with its clear story roof, and the enormous size of all the parts, especially of the cylinders and steam chest, made this engine a conspicuous and remarkable sight. It is fitted with a steam brake and steam reversing gear, controlled by an ordinary spring catch reversing handle—which, however, is only connected to the main valve—the cut-off being varied by another reversing lever working on an ordinary notched quadrant.

THE AMERICAN SYSTEM OF ELECTRIC LIGHTING.

Electric lighting in the United States is at the present time almost entirely confined to arc lights, which are very generally employed not only in the large cities, but also in the smaller towns where oil is the only other illuminant. The brilliant appearance of the streets contrasts favourably

FIG. 1.



with those in England, as with a very few exceptions arc lighting for streets is a thing of the past, and we are relegated to what, under the very best conditions, is a poor substitute, namely, gas. In America, as at home, the gas interest is controlled by powerful companies, and it is not to be supposed that these have given up the battle and allowed their electric rivals to obtain the contracts for lighting the streets without great opposition. In New York and Boston large lamps were erected burning each from six to sixteen times as much gas as the ordinary street burner; the price of gas was cut down to about one-third; still it was found that each of them cost the city just about double what was being paid for electric light. These torches, as they are called, were set up to show that gas in improved burners could compete successfully with electricity for extensive illumination; but the result has been most disastrous to those concerned in the undertaking. The average price of gas in the United States may be taken at 2 dols. per 1000 cubic feet; in some places, however, it is customary to allow a rebate for cash of 20c. to 30c. per 1000ft. The usual contract price for electric light is 50c.—2s. 1d.—from dusk to midnight, or 75c. from dusk to daylight; and this price includes carbons and maintenance of the lamps in good repair. The Street Commissioners of the city of Hartford report: "Where the gas lamps burning twenty-six nights per month cost the city 35 dols. each per annum, experience shows that each electric light displaces 6½ gas lamps, and gives at least ten times the light. At 65c. per night each, these electric lamps burning twenty-eight nights per month instead of twenty six, cost the city 211·90 dols. per annum each, against 227·50 dols. for the 6½ gas lamps, showing a net saving of 15·60 dols. per annum for each electric light."

The companies principally engaged in this business are those employing either the Thomson-Houston, Brush, or Maxim-Weston systems; the first, although the latest in the field, is rapidly distancing its competitors both as regards the number of lights maintained and the cost of them. The usual plan adopted in towns where there is no electric light is to start a supply station in some central position, and immediately to run overhead wires in all directions to suit the users of the light. For this purpose, where a street-lighting contract has to be carried out, poles are either erected on the side walk, or those already carrying the telegraphic wires are made use of. Although great disfigurement of the streets is noticeable to English visitors, there is a certain advantage in being able to supply customers in all directions without going through the form of obtaining way leave, which is, moreover, often taken for granted without asking. The lamps are, as a rule, carried on wrought iron standards, which are let on to a cast iron base; in Philadelphia the Brush lights are fixed to the side of the posts which carry the electric light circuits above in the usual way. In some instances a light

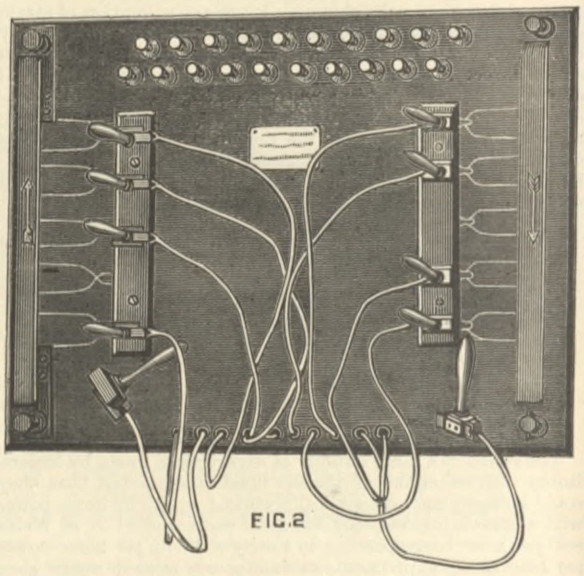
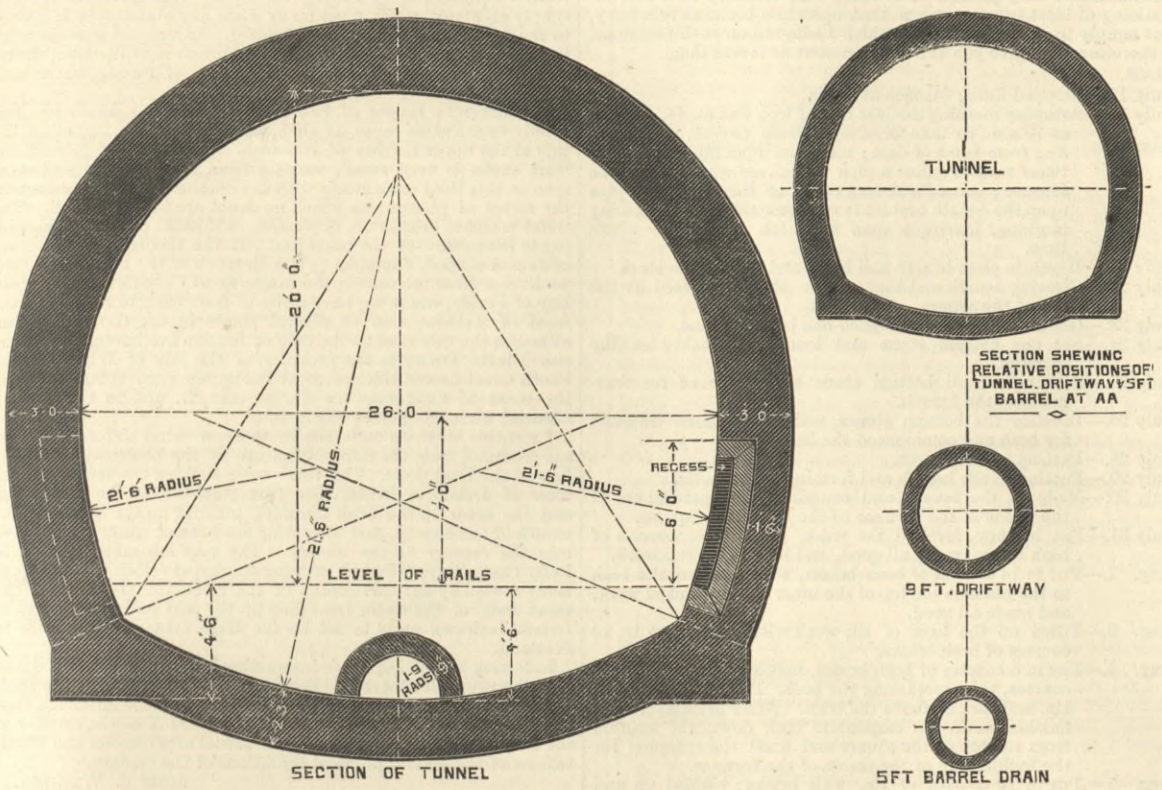


FIG. 2

tower is erected, which is either of an open work design, as shown in Fig. 1, or consists of a central post, round which the arc lamps are slung in a frame, which is lowered for trimming purposes. The tower system does not appear to increase in favour, but has its advantages for open sites, and has been adopted by the authorities for lighting the bend of the East River, New York, where the obstruction known as Hell Gate has been removed. The tower in question is of the description illustrated, and is 175ft. high. The question of lighting from central stations has often been discussed, and certain difficulties have been brought forward, such as the noise, and the consequent nuisance to adjoining property. These objections have been met by special arrangement of the machinery, and stations are now found in the most busy streets of the American cities. One of the newest is that erected by the Merchant's Light and Power Company, of Boston, which consists of a basement and dynamo room above, the length of which is 110ft., and width 46ft. The boilers, six in number, are fixed in the basement, ventilation being maintained by two fan blowers. Coal is run into bins from the street; it is then mixed, weighed, and transferred to the furnaces by small cars. The engines, which are all of the Armington and Sims pattern, are in the dynamo room, and are in the centre of the room, the Thomson-Houston dynamos being in a long line on each side. The wiring is arranged so that the negative wires from the dynamos run under the floor, as are also the short-circuiting field wires, while the positive wires are run along either wall, and on the ceiling are those leading to the pilot lamps, one of each is included in each working circuit. The switch board is of special design, plugs being used which are so arranged that the circuit can be easily changed, and by means of wires leading from the field magnets to the board, they can be short-circuited so that the current may be interrupted without causing any flash. In smaller installations the distribution switch shown in Fig. 2 is employed, which fulfils the same purpose. When finished, this station will contain sixteen engines and thirty dynamos, each producing thirty lights. There are forty smaller supply stations now at work under licence, and as these average 100 lights each, and only represent the enterprise of a single system, an idea can be formed of the extensive business in arc lighting throughout the United States and contrast it with the results obtained during the same period in England. With reference to Fig. 2, it should be noted that the loose handles on each side are slid on the brass pieces.

* This number varies according to the arrangement of valve gear adopted.

SECTIONS OF THE SEVERN TUNNEL.



THROUGH the courtesy of Mr. T. A. Walker, C.E., the contractor for the construction of the tunnel, we are enabled to give the accompanying sections of the Severn tunnel, and they will also serve in further illustration of the paper by Mr. John Clark Hawkshaw. They also help to a conception of the size and difficulties connected with the undertaking. No drawings, however, can convey an adequate conception of these. Nothing but a visit will do this, and no one can make such a visit without being impressed with the grandeur which characterises the undertaking in its realities, as compared with works of any magnitude on paper. The courage and perseverance displayed by engineers in Mr. Walker's position are such as would make the obstacles usually met with in what are commonly described as difficult pieces of constructive work seem really trivial. The enumeration already given of the number and sizes of the pumps required to keep down the water, convey nothing as to the almost insuperable obstacles which the inrush of over two millions of tons of water per day have put in the way of finding room for and modes of proceeding with excavation and masonry, as well as provision for the escape of this river of water. At the recent visit of the Institution of Mechanical Engineers, Mr. Walker, who sumptuously entertained the visitors, told a little of the difficulties that had to be overcome, and he told of the troubles the pumps had given him.

The following table gives some figures not given in the paper already referred to:—

Description and Capacity of Engines and Pumps.

Place.	No.	Description.	Pumps. Dia.	Pumps. Stroke.	Engines. Dia.	Engines. Stroke.	Remarks.
			in.	ft.	in.	ft. in.	
Sea wall	2	plungers	15½	7	18	2 2	horizontal
,, ...	2	buckets	15	7	18	2 2	,,
,, (Ableton-lane)	2	,,	15	7	18	2 2	,,
Ludbrook (old pit)..	1	bucket	31	9	60	9 0	60in. engine beam No. 3, } In course of erection.
,, ,, ..	1	,,	35	9	70	9 0	70in. beam engine } In course of erection.
,, ,, ..	1	plunger	37	10	70	10 0	No. 2, do. do. } In course of erection.
,, (iron pit)	1	bucket	35	9	75	9 0	beam engine
,, ,, ..	2	plungers	26	10	50	10 0	bull engines
,, (new pit)	2	,,	18	10	} 70	10 0	beam engine
,, ,, ..	1	bucket	28	10			
5 m. 4 chs. (winding pit) ..	1	plunger	20	7	18½	3 0	horizontal
Do. (pumping pit)	2	,,	18	8	25	4 0	,, (pair)
,, ,,	1	bucket	28	9	41	9 0	beam engine
,, ,,	1	,,	31	9	60	9 0	,,
Marsh pit	1	plunger	15¼	7	22	7 0	bull engine
,, ...	2	,,	15½	7	16	2 0	horizontal
Hill shaft	2	,,	15½	7	18½	3 0	,,
Shaft at 6 m. 33 chs.	2	buckets	15	7	18½	3 0	,,

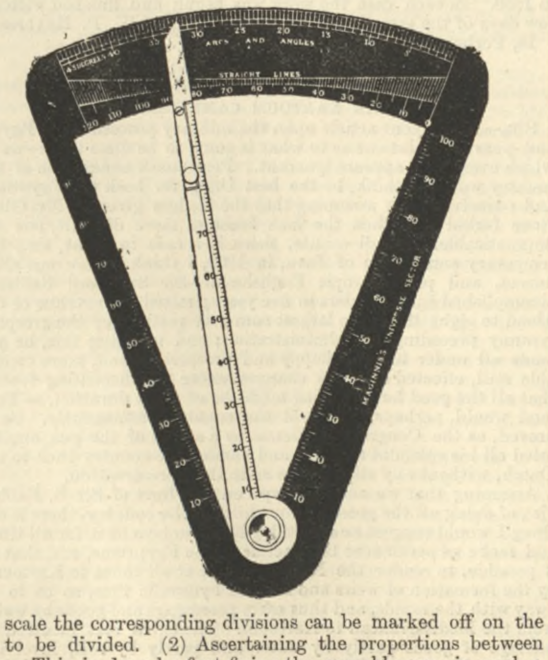
Never has a piece of work been carried out necessitating such enormous pumping power. The undertaking has now been in hand about eleven years, and three thousand men are employed on it. For these and their families Mr. Walker has built a small town, with provisions for education and recreation.

Some time since the chapel built by him for their use was burned down, and as an illustration of what may be done in building, it may be mentioned that a large well-built stone chapel, of an unusually substantial and comfortable character, capable of seating about 1200 people, was re-built in three weeks. Our longitudinal section of the tunnel, see page 233, is made in three parts for convenience. The middle and shorter pieces give the English side, while the lower part joins the upper part, and shows the approach to the Welsh side. In the right-hand part of the upper section will be seen the position of the great head wall that was built to keep back the water, and in which is placed the door, which had to be shut by a diver. For this purpose he descended the shaft and traversed a considerable distance therefrom, under water—a long distance from any possible chance of help should accident happen. He succeeded in the job, and nothing but remarkable courage enabled it to be done.

In the longitudinal section the parts in which the masonry are completed and partly completed are shown by the black and black and etched sections; and the relative positions of the tunnel itself, the driftway, and barrel drain are shown in the transverse sections as they occur at A A, near the Sudbrook side. The great head wall has yet to be removed, and in order to grapple with the pent-up water, a driftway is being driven from within the tunnel to get round this wall and get at the water, so as to keep it under control. This is a difficult operation, and one attended with great possibilities; but no doubt Mr. Walker will be able to overcome this, and he hopes to run trains through the tunnel next July. Mr. Walker is ably assisted by Mr. A. G. Luke, the resident engineer, and by his own able staff; Sir John Hawkshaw, and Mr. Chas. Richardson, the projector of the tunnel, are the chief engineers.

MAGINNIS'S UNIVERSAL SECTOR.

AMONGST the smaller articles exhibited at the recent Wolverhampton Exhibition, was the "universal sector," by Mr. James P. Maginnis, 23, Queen Anne's-gate, Westminster. The instrument is shown in the annexed figure, and has an arm movable about the hinge shown, the arm and the edges of the sector being divided, as represented in the illustration. The instrument is readily adaptable to several different purposes. (1) Dividing a line into equal parts. This is done by first setting the movable arm A at some division on the straight line scale, the number of which is conveniently divided by the number of parts into which the line is to be divided—if into 8 parts, say at "80," as shown. The instrument is then placed on the paper, so that the line to be divided, when produced, passes under similar readings on the scales marked on the two arms, and at the same time the portion of line on which divisions are to be marked must be intercepted between the movable arm A and the right-hand arm B; and by moving the arm to the correct points on the straight



line scale the corresponding divisions can be marked off on the line to be divided. (2) Ascertaining the proportions between lines. This is done by first fixing the movable arm in such a position that the distance between "100" on A and "100" on B is exactly equal to the length of the longest line, and then placing the instrument on the other lines, one at a time, to find at what points their extremities touch similar readings on each of the scales A and B. For instance, if the extremities of a line touch at 45 on each scale, then that line is $\frac{45}{100}$ths, or 45 per cent. of the length of the first line. (3) Finding the centre of a circle is accomplished by placing the instrument on the paper, so that the edges of the two arms B and C are tangents to the circle; and then drawing a line down the edge A when that arm is on the centre point "60." If this is done at several points round the circle, where the several lines intersect will obviously be the centre of the circle. (4) Reducing or enlarging the ordinates of railway or other curves is done by the converse of the method adopted for finding the proportionate lengths of lines. For instance, if the original ordinate is equal to the distance between "100" on A and "100" on B, then a line four-fifths of that length will be found between "80" and "80," and so on for other ratios. (5) Angles may be set off or subdivided by using the scale marked "arcs and angles." Being in handy form, the instrument commends itself to all engaged in plotting, designing, and other work.

INTERNATIONAL INVENTIONS EXHIBITION.—The latest date for sending in applications for space has been extended from the 1st October to the 1st November.

PNEUMATIC STREET RAILWAY.

THERE has just been completed at the Risdon Ironworks, San Francisco, an experimental car to be run with compressed air by a new system, a trial of which was made recently. The subject is one of great interest, more especially as the system will be tried where close comparisons can be made between it and both cable and horse car as to relative economy. In the new plan there is a storage and charging pipe which carries the air below the surface of the road bed all along the route, contiguous to the track. Through a system of valves attached to this pipe, closely set together within the track, the pipe may be tapped and the receivers replenished at any and all points on the route. In this way the system is so arranged that the car is never removed from its source of supply, and has no determined distance to travel with each charge, so that it may have a minimum capacity as to storage room and pressure of air instead of the maximum, as when the length of the journey to the charge is absolute and fixed. Compressed air motors have been run a definite distance without replenishing, as from end to end of a route and back, and suggestions have been made to run from station to station, using a pipe connection between, but in all cases provision has had to be made for carrying the heaviest possible load of passengers under the most adverse circumstances likely to occur, such as those arising from very frequent stoppages, bad condition of the track, accidental delays, &c. The definite points could not be passed without refilling the receivers, and either the engineer had to go or the motor itself had to be taken to the station off from the main line in the act of refilling, this system of operation leading to all the difficulties which have heretofore surrounded the use of compressed air as a motive power for street roads. No practical system has been put in use so far by which the motor could be resupplied with air at any and all points on the route.

The motor which has just been tried is constructed as an open car, after the style of the cable road dummies, and the air receivers, are placed under the seats. From these receivers, which are connected by a pipe, a hose connection is made which terminates in a metal nozzle, in the end of which is fitted a valve to make connection with the service pipe, as described hereafter. The main service pipe is placed underground, near the track, and is large enough to have in itself storage capacity sufficient to insure that the drawing off of each charge for the motors will not greatly decrease the pressure. It is thought that a pipe of 5in. or 6in. diameter will do for roads running cars five minutes apart, while it should never be less than 4in. in diameter.

The main pipe is provided with right-angled branches, say every 300ft. more or less, which lead to the centre of the track and terminate in valvular outlets. The nozzle connected with the reservoir on the cars fits into this valvular outlet, so that air comes from the main pipe into the reservoirs when wanted. The valvular connection is peculiar, and the action is automatic. When the nozzle is put in, the air can flow; when withdrawn, the valve in the outlet closes. This is an important feature, and the details are quite ingenious. Of course, other devices than this may be used, but a practical trial has demonstrated the utility of the plan adopted. It may be desirable, too, to place reservoirs at the outlets, so that a great volume of air may be immediately at hand to draw from, and a quick operation in replenishing the receivers affected. Air compressors may be placed at one end of the line only, or at both ends, as circumstances dictate. The air engines connect in the ordinary manner with the driving wheels on the cars.

The system of operating is as follows:—The storage and supply pipe being filled with air, say at a pressure of 100 lb. per inch, the motor's receivers are filled therefrom at the depôt at full pressure. On starting out as it proceeds on its trip, the air is used on the motors either at full pressure direct from the receivers, or reduced to say 30 lb. by passing it through reducing valves. It is expected that the new cars can run on the Howard and Mission-street routes, where they are expected to be placed, at a pressure of 30lb., but this can be increased at will by means of suitable mechanism. When the conductor strikes the bell for a passenger to get on or off, the engineer stops at just where the next valve of the supply pipe is located or within a few feet thereof. These valves are placed at street crossings generally. The engineer then takes down his feeding nozzle and inserts it into the hole in the street, and connects. The air rushes through the nozzle and fills the reservoirs until the bell sounds to start, when the nozzle is taken up and replaced on its stand. The engineer need not wait to get the first few pounds of pressure, but may start with such pressure as he has obtained. In this way no unnecessary delay occurs.

The car or motor need not be required to travel over six or eight blocks, or even a less distance, where stops are frequent. The valves may be placed at crossings, or even every 100ft. if necessary. It is desirable to be able to refill the receiver at every stop, to have great pressure when starting. Several suggestions have been made to operate street railroads with compressed air, carried near the track, but none have included within their scope the system here proposed, which is the invention of Mr. George Pardy, of this city. In this system the maximum weight of the load and contingencies of the trip do not control, but have only the effect of limiting the distance the motor will be capable of travelling without having recourse to the supply pipe, constantly at hand. In fact, those stoppages, which are of necessity caused by taking or leaving passengers, are the only ones necessary to make, it being calculated that these will be ample in most cases to give the required opportunity to replenish the receiver. In running on this system they get over the great loss of power required to move a cable. On the cable roads 68 per cent. of the power is necessary to drive cable alone without counting cars or passengers. Then, again, it is different from steam dummies or locomotives in this—there is only one central fire for the compressing machinery, instead of separate fires, boilers, &c., for each machine. They expect to utilise 50 per cent. of the useful effect of the compressed air. One engine supplies all the cars. These cars are expected to go up a grade of 1 in 15.

The experimental trial of the system already made proved very satisfactory to the promoters. The car ran with 100 lb. pressure for three-quarters of a mile one trip, and seven-eighths of a mile the second trip. The car weighed about 3½ tons and the passengers 2½ tons. The highest speed attained was 16 miles per hour, and the car went up a grade of 1 in 37 at 8 miles per hour. The connecting valve worked satisfactorily. It is probable that this system will be adopted by the Howard and Mission street car lines.—*Min. and Sci. Press.*

COAL MINING IN CHINA.—According to an official report published last week, coal mining in China has its peculiarities. At Kaiping the demand for lump or good coal is limited, and in almost all cases coal for native consumption will actually sell better when small than if it had a large proportion of lump—a rather curious state of affairs. Again, the natives have strange notions as to the rights of property. In spite of proclamations, &c., they began to mine coal in ground actually worked by the Kaiping Company, and naturally drained by its machinery. This led to riots and serious trouble. The company was promised a monopoly of mining within 10 li of its colliery, but this arrangement does not seem to coincide with native notions of fair play, and, consequently, difficulties have arisen. A few accidents have lately occurred at the pit, and three men killed, chiefly caused, it is stated, "by attempts to rob pillars and by their own rascality." The coal-washing, brick-making, and tile plants, patent fuel machinery, and quarries are quite idle, and this, we read, is "entirely owing to want of energy in opening up a market." The opinion is expressed that all that is needed to make the company a perfect success is improved communication with Tien-tsin, even if only by railway extension to Pehtang, and effective commercial management of the company's affairs in every detail under foreign control.

LETTERS TO THE EDITOR.

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

THE ROCKET OF SEPTEMBER THE 15TH, 1830.

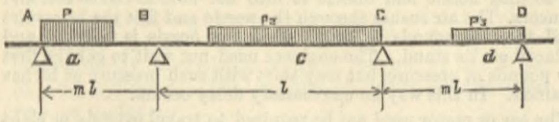
SIR,—I notice your article in yours of the 12th inst. I was at the opening of the Liverpool and Manchester Railway on the 15th of September, 1830, and well recollect seeing the Rocket. There must be some great mistake about the sketch you show in your supplement. Your figure at page 191 is as near correct as any man's memory can say. On that day she had most certainly a wooden tender, with a wooden cask on it painted green, to hold the water. The cylinders were diagonal, as shown in that figure, and the chimney and top were the same. The fire-box was as shown in that figure. It is a great pity that such a nice little sketch as you have inserted should be handed down to mislead posterity, as it is certainly a most incorrect representation of what the Rocket was at the opening of the Liverpool and Manchester Railway, and some things glaringly point out there is some mistake. The tender, for instance, just such a tender as was introduced by Edwin Bury. The horn plates particularly denote this. The spring balance in this shape was not introduced till years after, neither was the chimney top introduced in that shape until years after; and I am inclined to think that glass water gauge was not in existence; most certainly it was not on the Rocket in the form shown. The oil cup forged solid on the connecting rod strap did not exist. In fact, the cylinders were diagonal. The boiler barrel is shown as if it were lagged with timber. The first introduction of boiler clothing was first a coat of felt; then covered with canvas, and stitched by a sail-maker, and painted green. There must be some fog about. Mr. Nasmyth says he made this sketch at Liverpool on the 12th of September, 1830, whilst the engine was at rest after some experimental trips the day before the opening. How is this? The line was opened on a Wednesday, the 15th of September, 1830, and if Mr. N. made this sketch on the 12th, it must have been made on Sunday. Surely they would not be experimenting on the Sunday. I cannot account for it, but I have for many years thought that the Rocket would be more inquired after some day. One day I was on the Rocket's foot-plate, and a part of the old Rocket became detached. It almost instantly got into my hands, and has remained in my possession ever since. Why I should think so much of it at the time I do not know. I may also say that many of the locomotive engines which were running on the Liverpool and Manchester Railway forty-five years ago came into my hands twenty years ago, namely, the Victory, Buffalo, Stag, and many others; also the Shark, which opened the Grand Junction Railway in 1837. I well recollect seeing the Rocket come to Oldfield Lane for the doctor to go to Mr. Huskisson, who, it was said, they had left at the rectory at Eccles. The news of the accident to Mr. Huskisson threw a great gloom over the day's proceedings. Some time after the passenger train in which was the Duke of Wellington arrived. He was in a carriage trimmed all over outside with crimson cloth. After the opening this carriage was put in a short siding near to the Ordsal Lane level crossing, and remained there until all the cloth rotted off it. I have a considerable collection of parts of early locomotives.

Ashton-under-Lyne, September 15th. I. W. B.

CONTINUOUS GIRDERS.

SIR,—If the authors of the paper p. 171 had written "the strain that the girder is subjected to" instead of "the *greatest* strain that the girder *can be* subjected to"—p. 173 l. 18—and if they had not used the expression "rolling load," I should have raised no objection; but a rolling load may cover a portion of a span, and, although this is very seldom taken notice of, they must know very well that it is not right, as such loading produces greater moments at certain points than the cases of loading considered in the paper. Between the supports and the points of contrary flexure all moments would be greater, and the increase at certain points may amount to 50 per cent. and more.

I will now give a formula which I use for the calculation of these moments, and which, I believe, has not yet been published.



Let A, B, C, D be the moments over four intermediate supports of a continuous girder of uniform section; let the lengths of the three spans be $m\,l$, l, $m_1 l$; the units of loading, p_1, p_2, p_3; let the proportions of the loaded parts to the whole spans in the sense of the sketch be a, c, d, and put for the sake of brevity,

$\alpha = 2a^2 - a^4$; $\beta = 2c^2 - c^4$; $\gamma = 4c^2 - 4c^3 + c^4$; $\delta = 2d^2 - d^4$; then:

$$B = \frac{1}{1 - 4(1+m)(1+m_1)}\Big(2m(1+m_1)A - m_1 D + [p_1\gamma + m_1^3 p_3 \delta - 2(1+m_1)(m^3 p_1 \alpha + p_2 \beta)]\frac{l^2}{4}\Big)$$

$$C = \frac{1}{1 - 4(1+m)(1+m_1)}\Big(2m_1(1+m)D - mA + [p_2\beta + m^3 p_1 \alpha - 2(1+m)(m_1^3 p_3 \delta + p_2 \gamma)]\frac{l^2}{4}\Big)$$

If, differently from the sketch, the load on the span B C joins B instead of C, β and γ change places in these equations. There are here two equations for three spans and four moments, and there would be $n - 1$ equations for n spans and $n + 1$ moments; but as the moments at the two ends would be *nil*, there would only be $n - 1$ unknown moments. Putting in the above equations $a = c = d = 1$, and $m = m_1 = \frac{l_1}{l}$, and eliminating A, we get the well-known equation:

$$Bl + 2(l + l_1)C + l_1 D - \tfrac{1}{4}(l^3 p_2 + l_1^3 p_3) = 0.$$

3, Westminster-chambers, M. AM ENDE.
September 20th.

NEW SYSTEM OF MINING PLANS.

SIR,—The usual system of mining drawings which requires several horizontal projections and vertical sections in order to show the strata traversed and the workings of a mine, has often been found inconvenient and incomplete by engineers, and difficult of comprehension by others. These difficulties were brought more clearly before me whilst I was engaged in making drawings of some of the gold and silver mines of Dakota, Colorada, and Nevada a few years ago, and made me consider whether by some means they might not be lessened. After considerable study I devised a system which shows the entire works and strata on one sheet, and is also practically useful to the engineer, as all parts can be measured by scale.

Drawings made on this system were submitted to some of the leading mining engineers of California, and highly approved of by them. Such plans would be especially useful to the directors of mining companies in following the reports of the managers.

Circumstances have led me to abandon the profession of engineering, and my duties no longer allow me to devote myself to the perfecting and introduction of this new system. I shall be glad to give further information to any of your readers who will take it up.

South American Journal Office, JOHN SAMSON.
37, Walbrook, E.C. September 20th.

REBUILDING BLAST FURNACES.

SIR,—I send you herewith a copy from an entry in an old diary of mine, which I happened to take up a few days ago, if you think it worth giving space in your valuable paper. The subject may be interesting to some of your readers who are acquainted with the history of the blast furnace. I do not intend to enter into the old methods and long process of blowing out, clearing out, and rebuilding of blast furnaces when that operation becomes necessary, but simply to show the method which I adopted on such occasions. I therefore shall give you the daily account as it was done.

1856.

July 17.—Stopped filling furnace at 5 p.m.

July 19.—Saturday morning the last cast of iron was made. Began at 10 a.m. to take brickwork from tweers, and sand, &c., from front of dam; made an opening in the back tweer wall to admit a pipe to convey water inside the furnace; turned a stream of water through a 3in. pipe upon the hearth and let it run constantly until Monday morning, leaving a man to watch during the whole time.

July 21.—Began to clear hearth and bear, and take down stack.

July 22.—Clearing hearth and bear; put a strong scaffold at the top of the square.

July 23.—Got out the bear and loaded one bottom stone.

July 24.—Set one bottom stone and loaded the other on the carriage.

July 25.—Set the second bottom stone and prepared for commencing the hearth.

July 26.—Levelled the bottom stones, and set up small trammel for bosh and commenced the hearth.

July 28.—Putting in the hearth.

July 29.—Putting in the hearth and forming tweer holes.

July 30.—Made up the tweers, and completed the getting out of the inside of the furnace to the top of the square.

July 31.—Put in timp, levelled the work, put in five courses of bosh bricks, made all good, and backed up the work.

Aug. 1.—Put in 14 courses of bosh bricks, which raised the bosh to the plate on the top of the inner square backed work, and made all good.

Aug. 2.—Filled up the back of the work with sand; put in 14 courses of bosh bricks.

Aug. 4.—Put in 8 courses of bosh bricks, making in the whole 41 courses, this completing the bosh. Put in 9 courses of 1in. wall bricks above the bosh. After bricklayers had finished work, the carpenters took down the scaffold from the top of the square and fixed the trammel for the building up of the inside of the furnace.

Aug. 5.—Put in 13 courses of 1in. wall bricks; backed up and built up the outside red work to the second iron hoop.

Aug. 6.—Put in 12 courses of 1in. wall bricks; backed up and built up the outside red work to the fourth hoop; put up the first scaffold for outside work.

Aug. 7.—Put in 24 courses of 1in. wall; backed up and raised the outside red work to the sixth hoop.

Aug. 8.—Raised the outside scaffold; put in 22 courses of 1in. wall bricks; backed up and raised the outside red work to the ninth hoop.

Aug. 9.—Finished the inside work and also the outside red work to the gallery; put on the cornice and gallery frame.

Aug. 11.—Filled in the gallery frame; fixed the mouthpieces; built up between them; put on the ring and built up the tunnel head, and put on the first hoop; took all the scaffolding and trammel out of the inside of the furnace; made all clean and put in the first cokes for filling the furnace.

Aug. 12.—Finished the tunnel head and began to fill the furnace.

Aug. 13.—Put in the first mine between 11 and 12 a.m.

Aug. 18.—Put on the blast at 3.15 p.m.

I may just observe that in this instance time was of great importance for several reasons. The effect of turning the water on this mass of congealed material at the bottom of the furnace was this: that the water worked round and underneath it, and completely broke up the stone blocks which formed the original hearth, leaving the bottom of the bear perfectly smooth. The size of this bear was about 14ft. long, 12ft. wide, and 4ft. thick, and the estimated weight from 35 to 40 tons.

The first time I adopted this plan was in January, 1851; the second in January, 1852; the third in July, 1856; and the fourth in 1858. In each case the work was begun and finished within a few days of the same length of time. W. P. BAYLISS.

18, Perham-road, West Kensington, S.W.,
September 17th.

THE KARTOUM CAMPAIGN.

SIR,—I note your article upon the military proceeding in Egypt, and your speculations as to what is going to be done there—as to which everybody appears ignorant. Permanent annexation of the country would, I think, be the best thing for both the Egyptians and ourselves; but assuming that the pledges given by Mr. Gladstone forbid this, then the task becomes more difficult, but not impracticable. At all events, there is a case in point, viz., the temporary annexation of Java, in 1809, I think, where one able, honest, and philanthropic Englishman—Sir Stamford Raffles—accomplished such wonders in five years; raised the revenue of the island to eight times the largest sum ever realised by the grasping tyranny preceding his administration; and in doing this, he yet made all under his rule happy and prosperous, and, more creditable still, effected all these changes under the dispiriting feeling that all the good he was doing might be of short duration, as England would, perhaps, not hold the country permanently. So it proved, as the Congress of Vienna by a stroke of the pen annihilated all his splendid reforms, and handed the country back to the Dutch, without any stipulations as to their preservation.

Assuming that we act in Egypt on the lines of Sir S. Raffles, viz., of doing all the good we can whilst in the country, there is one thing I would suggest as something likely to benefit it for all time, and make us permanent benefactors to the Egyptians, and that is, if possible, to render the Nile navigable at all times to Kartoum, by the formation of weirs and locks or hydraulic lifts, so as to do away with the rapids, and thus carry passengers and goods by water from the Mediterranean to Kartoum. The extra cost incurred by carriage of goods partly by water and partly by rail, involving extra handlings and delays consequent on same, is the stumbling-block to the Euphrates Valley Railway project. If a clear waterway be made as I suggest, there is also a line of defence opened, either by patrolling the river with gunboats, or by moving troops to any point on it where needed—a slight improvement upon our present proceedings.

If this suggestion has your approval, perhaps you will kindly give it insertion in your influential paper. C. E.
September 22nd.

TIDAL ACTION IN ESTUARIES.

SIR,—Mr. Boult, in referring to Mr. Hurtzig's excellent letter on the above subject, takes exception to the term head of water at the mouth of the River Mersey, calls the phenomenon of the high-water levels in the upper reaches anomalous, and asks for an explanation of the increased rise of tide on those parts of the coast furthest from the Atlantic. I think he will find, upon consideration, that there is no anomaly, and that the explanations are very simple; but I may mention that these points have no bearing whatever upon the main issue of Mr. Hurtzig's letter, which treats in an original and able manner of a particular case, viz., the action of tides in estuaries, and this cannot be well discussed under the general head of "tidal action," which includes all the very interesting and curious phenomena of ordinary tides, double tides, rotary tides, no tides, &c.

If there were no head of water at the mouth of the river the water could not possibly flow into the estuary, and the high water in the upper reaches does not occur simultaneously with that of the mouth; but in the Mersey it is several hours later, the difference of time of the high water depending upon the position of the point in the upper reaches. This difference of level is simply due to the impulse imparted by this head to the inflowing water, which, in the confined portion of the upper reaches, can only restore equilibrium by raising its level. This increased level is simply an afflux, which must occur when any obstruction is offered to the flow of water in an open channel. In a closed pipe, as in an hydraulic ram, this restoration of equilibrium is utilised, and water with a level of only 3ft. or 4ft. is capable of raising water over 100ft. high.

The different ranges of tide mentioned by Mr. Boult are due simply to the same cause as that which raises the height of the tide in the upper reaches of estuaries. The range of tide in the main ocean is very small, varying from 2ft. to 4ft. only; but as soon as this tidal wave meets with any obstruction then commences the series of phenomena which no doubt are familiar to all. The water is either heaped up, depressed, held back, or rotated, according to the nature of the coast line. If the mouth of the estuary be funnel-shaped, and open to the direction of the flow of the tide, we have a great increase in the range, as at Chepstow, and in the Bay of Fundy, where we have a rise of from 50ft. to 70ft. Off the coast of Arklow, also at several points in the German Ocean, although the tide runs at the rate of four or five knots, there is no rise or fall. Owing to the presence of the Isle of Wight on the South Coast double tides occur at Poole; the same thing occurs off the coast of California for similar reasons, and in the English Channel we have distinct rotary tides.

I mention all these facts simply to show what different effects are produced from the different nature of the obstructions to the flow of the tidal wave. The tidal wave striking the south-western coast of Ireland is divided, one part going along the east coast, and the other up the Irish Channel, meeting again north of the mouth of the Mersey, and so causing the head of water which flows into the estuary of the Mersey. The very low range of tide in Bally Castle Bay, although running at a great velocity, is very probably caused by the narrowness of the inlet, and also because the great bulk of the water travelling up the east and north coast of Ireland is drawn away to fill up the large estuaries and locks in Scotland.

Referring to Mr. Hurtzig's interesting letter, there is no doubt that the principles there laid down are correct, and that the limit of the tidal action as marked in his diagram by the letter A exists in all estuaries, but the position of this point A in the estuary of the Mersey must be determined from actual experiments and observations of the several physical conditions of the estuary.

JOHN J. WEBSTER.

Stephenson-chambers, 35, Lord-street,
Liverpool, September 16th.

SIR,—I hope Mr. Hurtzig will not deem me obstinate because I still prefer the above heading; it seems to me desirable, as far as possible, to ascertain principles and not to add to the number of empirical rules, many of which are anomalous, and prevent a more correct appreciation of principles. Practically, Mr. Hurtzig appears to use the term head as equivalent to the level of high water, or the crown of my hypothetical weir; and, doubtless, it is the head of all the streams down to the level of low water. That is, it is the head of the tidal currents, but it is not always the top of the tide that is the highest level to which the tide rises.

As the position of the lines of high and low water vary continually, the course of a river may be conceived of as containing an indefinite series of sections, in each of which the level of high water is the head, whence streams descend to low-water level. But this conception appears very imperfect unless it be conjoined with the following facts: (1) that the tide is a mechanical power; (2) that the passage of water through any channel, other things being equal, depends upon the capacity of the reservoir. That cannot be filled higher than its head, or mechanical equivalent. Therefore, if the passage of water is to be increased, the reservoir must be wider, longer, or deeper, and if any of those dimensions is reduced the water delivered will be less. The opponents of the Manchester Ship Canal assumed that the execution of the proposed low-water channels by causing accretion would eventually diminish the capacity of the upper estuary or tidal reservoir, and, consequently, diminish the water passing through the channels from the Irish Sea. I hope this note, taken in conjunction with my last, which you inserted last week, will assist Mr. Hurtzig in his inquiry, for it is obvious, if the passage of water through any of the indefinite series of sections is reduced, the quantity delivered through others will also be diminished, until all the sections are damaged, and that involves a loss of scour. Allow me to add that the word "services" in my last should be "surfaces."

Liverpool, September 22nd. JOSEPH BOULT.

CONTINUOUS BRAKES.

SIR,—The letter of "An Express Driver" on this subject is highly interesting, and will not fail to awaken the attention of the travelling public. Its plain and straightforward style contrasts singularly with the utterances of Sir Edward Watkin and Mr. Moon before the meetings of shareholders of their respective companies. The letter is the echo of what thousands of other drivers and railway men say and think, both at home and abroad. "Express Driver" has earned the heartiest thanks of his professional brethren for having the courage of expressing the wide-spread opinions among them concerning a question which is beginning to receive somewhat more attention on the part of the public.

As I have had some extended experience in the working of both Westinghouse and vacuum brakes, I should be much obliged if you would allow me to make a few remarks on these important matters. I acquired most of my experience in Austria-Hungary, in a land where the simple vacuum brake has taken such a firm footing, owing to the omnipotent influence of the inventors, especially of Mr. Hardy, who is one of the leading engineers of the Southern Railway of Austria. I have, therefore, had the best opportunities to inquire thoroughly into this matter. The result of my comparative experience is that the vacuum brake is one of the worst and most treacherous appliances that can be used on a railway; and I really am at a loss to understand how it is that English railway companies, who have such an immense traffic, are not ashamed to keep on their trains a brake which has been so notorious only because of its failures. I never have found an engine where the Hardy brake was in order. The vacuum can only be maintained by keeping the ejector open, and the hoses are a perpetual source of complaints. It is useless to tell you that yonder, as here, the Westinghouse brake soon earned itself a well-deserved reputation. Engine-drivers are not easily deceived on this point, and the fallacious theories of their superiors in support of the vacuum brake would not intimidate them. In Austria a man will not be dismissed for writing or saying what he thinks about this matter. Engine-drivers are the best and ultimate judges of this brake question; both abroad and in England their verdict is in favour of the unconditional and universal adoption of the Westinghouse brake.

I could quote many cases of failure of the vacuum brake in Austria, along with instances where the Westinghouse brake saved a train from more or less serious accidents. But as I do not wish to trespass on valuable space, I shall be content to refer your readers to the accident that occurred lately at Lynn, on the Great Eastern Railway, and where, thanks to the Westinghouse brake, there was no loss of life or bodily injury to deplore. Facts are more eloquent than theories. What have Sir Edward Watkin and Mr. Moon to say about this accident?

I understand that the relatives of the deceased in the Penistone calamity are about to bring a joint action against the Manchester, Sheffield, and Lincolnshire Railway to obtain compensation. This case will be interesting, and if successful, constitute a precedent that may decide companies to adopt a really efficient brake. I have already pointed out in your contemporary, the *English Mechanic*, that the main charge to be brought against the Manchester, Sheffield, and Lincolnshire Railway, is that they are guilty of gross neglect in not providing their trains with an automatic brake, it having been proved that in very similar occasions the Westinghouse brake—and no other—saved a whole train from wreckage.

It would be monstrous that in a country like England people are not allowed compensation for loss of life or of limbs, when on some continental railways for a trifling thing a passenger easily gets £10 or £20!

It is sincerely to be hoped that before long the noisy vacuum brake will have been removed from all our fast trains, and become a thing of the past. The Westinghouse brake is alone the only good automatic brake, and no other system will ever be found that will beat it. E. Gobert.

Manchester, September 15th.

Sir,—I have read with very great interest the valuable details relating to continuous brakes, which have been given by your correspondent "An Express Driver." The results of his twenty-one years' experience cannot fail to be highly instructive. The good sound common sense written by this practical man is a striking contrast to the absurd statements lately made by Sir Edward Watkin and Mr. Moon upon the brake question.

Recently details have been given in your columns of several failures of vacuum brakes; the cry is, still they come! On Tuesday last, September 9th, the up express from Liverpool, Manchester, and Leeds, due at St. Pancras at 5.15 a.m., overran the platform at Leicester, past the signal at danger, and ran foul of the London Road Junction. The train was fitted with the "Clayton two-minute leak-off brake." "Passengers state that it was applied, and speed seemed reducing fast, when gradually the brake took no effect, and the train ran forward through the station." The train was not delayed, the driver will be fined, as usual, and there the matter ends. As explained in my letter last week, "leaking off" is not considered a failure, so of course this case will not appear in the Board of Trade Return. Now I am of opinion that "leaking off" is a very great failure, and a fatal defect. For an express train to overrun a station, and foul of a junction, is a very serious matter; and if, as frequently happens, a down goods train had been crossing from the down main to the down goods line, in front of the express—and I have constantly seen this done—a severe collision must have resulted from this dangerous continuous brake.

It has frequently been contended by advocates of vacuum brakes that the adoption of what they choose to call the "universal coupling" would render various forms of vacuum brakes interchangeable; facts have, however, often proved the incorrectness of this idea. Several instances have occurred of Great Western and Midland vehicles causing trouble on the North-Western and North Staffordshire Railways; the officials being seriously perplexed what to do, as when one brake was applied, the other came off, and *vice versâ*. The two automatic vacuum brakes are said to work well together, but in practice they do not do so. On Monday, 8th inst., the 12.20 p.m. express from Leicester to London was, as usual, fitted with the "two-minute leak-off brake," but, in addition, a South-Western Company's saloon carriage was attached near the tail of the train, the brake on which is not constructed to leak off. The continuous brake was applied to slacken speed near Luton; its power soon died away on the Midland carriages, but remained "on" upon the South-Western saloon; consequently, this important train had to be stopped, the brake released by hand, and a delay of three or four minutes was caused. On Thursday—4th—the 11.55 a.m. express from Manchester to St. Pancras was delayed, and had to be worked without the "two-minute" brake over part of the journey, as it was out of order, and no vacuum could be maintained. These cases are but a fair specimen of ordinary working, yet in the Board of Trade return hardly an instance is recorded against this most dangerous brake.

40, Saxe Coburg-street, Leicester, Clement E. Stretton.
September 15th.

Sir,—We engine-drivers are pleased to see that the letter of one of us has found a place in the *Times*, and "Express Driver" has put in words just what we all think and feel. He has now got a brake on his train which he can trust his life to, and he is able to say how nice and comfortable he does his work—one turn of his wrist and he has a brake block on each wheel. Now, Sir, I only wish I was in his fortunate position. For some time I worked the Westinghouse brake, and felt just as happy as he does, but now, after re-arrangement of traffic working, I am on trains without it; I am now working vacuum, and there is no feeling of safety or comfort in it. You see, Sir, there is no depending on it. Now on one occasion I was approaching a station; I tested the brake a mile off and found it all right; when I put it on to stop at a platform the brake would not act, and the train ran the full length past the platform. Well, Sir, I was soon off my engine, and found a sack cracked underneath the second coach. The inspector came to me two days after to inquire, and said Mr. ———, the superintendent, was determined to put a stop to these frequent failures, so I would have to be fined a day's pay. Now, Sir, don't you think it hard on us drivers that our directors give us a brake to work which we know is not safe, and then when it fails we get fined? I do. I felt an interest in this failure, so I got a look at the Board of Trade return, expecting to find it, but the company have not put it down, and when I looked over the list I see lots of other failures are not put in the Blue-book, sharing the same fate as mine.

I wish, with your correspondent "Express Driver," that directors would come and ride on the foot-plate with us, and just see how things are, and how much we do want a good automatic brake for our safety as well as for the passengers. I see by your paper Mr. Moon and Sir E. Watkin have lately been telling their shareholders which is the best brake. Now, Sir, I ask, with all due respect, what do they know about it? You see it is our trade, and when we have worked first one brake and then the other, don't you think we drivers ought to know which we can trust and which we can't? And if I am told correctly, neither Mr. Moon or Sir E. Watkin have a Westinghouse train on their line, so I don't just see how they can tell us much about it. I note in a paper that the Manchester, Sheffield, and Lincolnshire Company call the Westinghouse brake the "Board of Trade brake," but I say, Sir, it is the engine-driver's brake, because it is the only one drivers dare trust their lives to. I, like "Express Driver," don't wish to be discharged, so will not give you my name, but will call myself

September 16th. Another Express Driver.

Sir,—I think it is remarkable that in the last returns to the Board of Trade made by the various railway companies in the country, which show—or ought to—the failures of different kinds of brakes as used, the total number of burst hose pipes recorded against the Westinghouse system—viz., 265 out of the total number of 397 failures—shows clearly the weak part of this brake.

The question I desire to ask is this: Is india-rubber the only material available for this purpose? If it is it ought, in my opinion, to be very materially strengthened by being covered with canvas, or some other durable material. I do not specify canvas in particular, for surely it would not be difficult to fix upon a proper material.

Now I dare say some at least of these burstings have been caused by the action of grease or oil; but I have heard it stated that on the Lancashire and Yorkshire Railway all the india-rubber used for working the automatic vacuum brake they have unwisely adopted is coated with a grease-resisting compound; but I do not know with what results.

Now I should like to know why it is that we see so many hose pipes not protected in any way against grease or oil. Both enter largely into railway working. I have seen both the Westinghouse and vacuum hose unprotected. What I should suggest would be not the adoption of double-hose couplings as lately brought out by the Westinghouse Company, but a single hose as follows:—A good strong india-rubber pipe (failing a better material being found) well coated with a grease or oil-resisting compound; then the hose to be very tightly covered with a strengthening material, and over this another coat of the resisting compound as before mentioned. Of course, it might be found better to make the material used to strengthen, in one with the rubber, on account of cheapness. In any case, to my mind, an experiment is well worth a trial, and I hope to hear of my suggestion being acted upon, because anything that would tend to improve the most commendable life-saving appliance for use on railway trains yet brought out should have a fair and speedy trial, and I wish those who experiment all good luck in their endeavours to bring out a better hose pipe.

September 24th. Hose Pipe.

Sir,—Yesterday a trifling accident occurred on the Brighton Railway which demonstrated the value of an automatic brake. The 1.45 p.m. up train from Brighton, when running between Earlswood and Redhill, parted in the middle by the breaking of a coupling. The Westinghouse brake immediately locked every wheel automatically, the train stopped, the coach with the faulty coupling was detached, the train recoupled and proceeded after a delay of twenty minutes. If the train had been fitted with any kind of non-automatic brake the probability is that on the driver slowing for Redhill station, which was only a short distance ahead, the rear portion would have run into the front portion before the guard could have pulled up with his hand brake, and a serious collision would have occurred.

It is a question when the automatic brake is used whether the side or safety chains should not be dispensed with. In case of accident, all the wheels being locked, there is no danger of the attached portion running back on an incline. In the above case, steam being on when the coupling parted, the front portion went ahead and broke the safety chains with a severe jerk which caused considerable alarm through the train. Gerald J. Tupp.

Hammersmith, W., September, 16th.

Sir,—The letter of Mr. R. B. Martin, chairman of the Vacuum Brake Company, which appeared in the *Times* of the 18th instant, was, in some respects, well calculated to throw dust in the eyes of your readers, though it will be found by those who have taken part in the brake controversies of the past, to be only a repetition of arguments and misrepresentations, which have been constantly advanced by the Vacuum Brake Company, and as constantly refuted.

Mr. Martin's letter was, it is true, satisfactorily answered in many material points by the two letters which followed it, and which conclusively demonstrated many weaknesses and defects of the vacuum brake; but there are other points in Mr. Martin's letter to which I must ask you to allow me to reply, involving, as they do, subjects of constant misrepresentation by the Vacuum Brake Company.

It must not be forgotten that Mr. Martin's letter has arisen out of the correspondence in connection with the Penistone railway accident on the Sheffield Railway, in which twenty-four persons were killed and sixty-two seriously injured, as the result of the inefficiency of the vacuum brake. Mr. Martin has not a word of defence or regret for the failure of his brake to save life on this occasion, but he takes the opportunity to announce for the first time that his company has come to the conclusion "that, on the whole, an automatic brake is desirable." Up to the present time the Vacuum Brake Company have been consistent supporters of the non-automatic system, and uncompromising opponents of the well-known Board of Trade conditions. The Westinghouse Brake Company, on the other hand—though possessed of a better non-automatic brake system—have for many years advocated the principle of automaticity, and it is so far satisfactory to find that the Vacuum Brake Company have at last come to the same conclusion. Having done this, it is strange that Mr. Martin should now refer to what is known as the Euston Conference of April, 1881. This conference was composed of twelve gentlemen, locomotive superintendents and others, all specially favourable to the vacuum brake, whilst none of the companies who had adopted the Westinghouse brake were represented on the occasion. Of the twelve gentlemen present, nine recorded their opinions in favour of non-automatic, and three in favour of automatic vacuum brakes. Mr. Martin does not state whether the nine who were then of the same opinion with himself have been converted, as he and his company declare themselves to have been in favour of an automatic system.

Mr. Moon, the chairman of the North-Western Company, at whose office this conference was held, informed his shareholders in general meeting that "no man in his senses would trust his life to an automatic brake." Mr. Moon has since so far abandoned that opinion as to have informed his shareholders at the last general meeting, that whilst applying a non-automatic vacuum brake to his trains, he has fitted his brake vans with automatic apparatus. However useless this modification may prove to be, and we believe it will so prove itself for the avoidance of serious results in the event of an accident, it indicates, at all events, on the part of Mr. Moon, a step towards automatic action which is certain to be extended in the future.

All parties have now agreed that the Board of Trade were right in the position they have for so many years taken up, viz., that automatic action was a necessary condition in any efficient continuous brake. The question now left for discussion is simply, Which is the best automatic brake for general use on passenger trains? Or, in other words, What brake is best calculated to save life and property in the greatest number of the contingencies arising in daily traffic?

The two most recent accidents are excellent illustrations of the relative advantages of the vacuum and the Westinghouse brakes. At Penistone, with the non-automatic vacuum brake, twenty-four persons were killed and over sixty injured, after the engine of the train had run 500 yards and the passenger vehicles about 200 yards; whilst in the case of the accident near Wootton, the engine and carriages were brought to a stand within about seventy yards, and owing to the Westinghouse automatic brake not a single passenger was seriously injured. But the accident at Wootton was peculiar. Loss of life and limb in this case were prevented by a "store of power" left on the carriages when they were detached at Lynn from the engine fitted with the Westinghouse brake, and run forward from Lynn with an engine not so fitted. The brake was actually applied by accident, the guard having opened his brake valve in consequence of a severe jolt he received when the engine left the metals. The brake would, it is true, have applied itself the instant the separation occurred, and this with equal force. No automatic vacuum brake in existence would have enabled a similar store of power to be retained on the carriages for use in such a manner; and here I may explain that in the case of the Westinghouse brake every carriage is provided independently with brake power, analogous to an air gun, which discharges itself and applies the brakes on the fracture of the couplings, brake pipe, or other portion of the apparatus, even after the engine is disconnected from the train. There are many other contingencies which cannot be provided for in the use of automatic vacuum brakes, and which are completely met by the Westinghouse brake, such, for instance, as when carriages for certain stations are slipped without stopping the train. The automatic vacuum brake is not available on such slip portions, which sometimes consist of a number of vehicles, and therefore it cannot be held to fully comply with the Board of Trade conditions, as it is not in such a case self-acting on the slip portion in the event of an accident, nor can it be applied by the driver or guard. The automatic vacuum brake cannot be efficiently worked on trains of twenty carriages and upwards, whilst the Westinghouse brake has been successfully operated on excursion trains of thirty-five vehicles. To obtain the same power, the vacuum apparatus worked with a pressure of 10 lb. per square inch should be eight times as large as the Westinghouse apparatus worked with a pressure of 80 lb. It is therefore impossible to use with facility any means for retaining the vacuum power on the carriages, and shunting operations are thus rendered difficult with the vacuum brake, whilst with the Westinghouse they are carried on with ease.

Mr. Martin also refers to failures of different brakes reported in the Board of Trade returns. These returns are, however, entirely fallacious when taken without proper consideration and explanation. According to the evidence of these returns, if Mr. Martin's method of appreciation is followed, the now abandoned chain brake of the North-Western Railway was by far the most successful. Being only an emergency brake, and not being applied, as in the Westinghouse brake, for every stoppage of every train to which it is fitted, the application of the chain brake was rarely made, and its failures did not amount to any considerable number on the North-Western Railway. The Vacuum Brake Company has adroitly issued statements in regard to these failures calculated to mislead the public by mixing up trifling delays to trains, through causes of no importance, with failures closely connected with the safety of railway management. I need only repeat here what has been so frequently pointed out, in reply to misleading circulars of the Vacuum Brake Company, that if these so-called failures had always been reported by the Vacuum Brake Company as properly classified under the headings of the Board of Trade returns, they would tell very strongly against the vacuum brake and in favour of the Westinghouse brake. In fact, a large number of instances reported as failures of the Westinghouse brake are in reality the best proof of its success, and of the reliability of its automatic action; it informs the servants of the railway companies of any defect which requires remedy by automatically stopping the train, and refuses to allow it to proceed until such defect is removed.

Mr. Martin further refers to the Blackburn accident and Colonel Yolland's report. This report was fully answered at the time, and Mr. Martin should have added in common fairness, when speaking of Mr. Chamberlain's circular, that Mr. Chamberlain thought it right, in referring to Colonel Yolland's conclusion, to say that it was "not founded on such direct and positive evidence as to place it beyond doubt." An engine-driver was employed on this occasion who had only travelled as fireman on a few previous occasions on a train fitted with the Westinghouse brake, who had never before been in charge of an engine fitted with that brake, and was therefore ignorant as to the proper mode of applying it. He failed to use it at the right time to pull up his train on a sudden emergency. On the few occasions this driver had run to Blackburn before, the station was always clear; he had never previously taken that particular train into the station; he had himself only worked the brake two or three times before without any proper instruction, and the usual stopping place was at a point 165 yards beyond the point of collision. When he did apply the brake it acted perfectly, as was proved by the evidence of several passengers who swore that they felt it applied on the carriages before the collision took place, and every part of the apparatus was found complete and in good order after the accident. How the collision occurred is perfectly clear. The driver having just descended a steep incline three and a-half miles long, was running at a reckless speed up to the station, intending to proceed to the further end of the platform as usual, and to make a smart stop similar to what he had been doing at previous stations, when suddenly he found another train had got there first. He applied the brake, whistled, and reversed his engine, but for the want of about eighty yards further distance, came into collision with the unprotected train already there.

The extent of the adoption of the Westinghouse brakes on the Continent is not of great importance to the present question, but Mr. Martin's statements in regard to this are certainly incorrect. At the present moment Westinghouse brakes have been sold to railway companies on the Continent of Europe in the following countries, viz., Belgium, Holland, France, Germany, Austria, Hungary, Russia, Italy and Spain for upwards of 1700 engines and 17,000 carriages, and we know that we shall not be contradicted by Mr. Martin or any other person when we state that no other brake system in existence can show anything like that number in use on the Continent. The total number of Westinghouse brakes in use in all parts of the world exceeds 15,000 for engines and 80,000 for carriages. We leave the Board of Trade to deal as they think proper with the statement that their representatives are prepared to recommend some brake other than the Westinghouse for general adoption, but Mr. Martin has paid the Westinghouse brake the highest compliment in hinting that no other brake can fully comply with the conditions which the Board of Trade originally issued and have constantly adhered to.

We do not, however, ask for any interference of the Board of Trade or Parliament with the proceedings of the railway companies in this matter; we only desire after full discussion with complete information, and with a knowledge of all the facts of the case, that public opinion should be deliberately formed, and that the best brake, whichever it may be proved to be, shall be ulti mately adopted. Alb. Kepteyn,

Manager and Secretary of the Westinghouse Brake Company,
Canal-road, Kings-cross, Limited.
September 23rd.

SHOULD THE DEE BE LED INTO THE MERSEY?

Sir,—The Manchester Ship Canal was rejected because it was felt that there was a risk—how great no one knew—that the proposed works might lead to the silting up of the Mersey, a calamity which would not only extinguish Liverpool, and render the Cyclopean works of the Dock Board absolutely worthless, but would at any rate for some time bring to a standstill all the machinery employed in the cotton manufacturing industry of Lancashire, thereby paralysing a capital equal in amount to the whole of our national debt. Even now that this danger no longer threatens us, the question of keeping open the channel of the Mersey is a delicate one, and the last proposal is that works should be undertaken by which the bar at the mouth of the river shall be entirely swept away. Before this is done, I think engineers should express an opinion as to a project which I have never seen publicly ventilated, but which I believe to be fraught only with advantage to all concerned. What is wanted is to increase the volume and consequently the force of the "scour" of the "Mersey," by which the dangerous sand banks, which have been especially of late appearing and re-appearing with provoking pertinacity, might be swept clean out to sea. Now if a volume of fresh water, equal to that of the Mersey itself, could be brought into the estuary at or near Runcorn, it seems certain that great good would be effected, and this can easily and cheaply be done by making a channel for the river Dee from Chester to Runcorn. Any one who first looks at the map, and then travels over or better still, walks across the low-lying ground between Chester and the banks of the Mersey, will see how perfectly feasible is the scheme from an engineering point of view. In addition to the enormous advantage of a greatly increased "scour" to the Mersey, the whole estuary of the Dee would at little cost be transformed from a wild wilderness of sand, in which the river now loses itself, into about 100 square miles of good pastural or agricultural land. Perhaps Kingsley's exquisite ballad of the "Sands of Dee" will sound none the less sweetly in our ears, when those sands have been converted into rich farms and gardens, supporting no inconsiderable number of industrious and happy inhabitants. The old Cathedral City of Chester would have no reason to complain, for she would have better access to the sea than at present, and it is possible even that her old glories as a seaport might revive. Of course, the riparian owners on the lower Dee would have to be compensated, but the enormous tract of reclaimed land would amply provide for this and all other claims and costs. Should you favour me by giving this letter insertion, I trust it may lead men of greater special and general knowledge than myself to join in the discussion, and either show objections to the scheme, or as I believe they will do, that its execution would be fraught with great local and national advantage.

Wesen Wallensee, Switzerland, Samuel James Capper.
September 20th.

FLEXIBLE WHEEL BASE LOCOMOTIVE.

THE accompanying illustrations, copied from the *Scientific American*, represent a locomotive recently patented by Mr. Gabriel Fretel, of Porto Real, Province de Rio Janeiro, Brazil, designed to be used on railroads having steep grades and sharp curves. The connecting rods are provided with devices for automatically lengthening or shortening them when the locomotive runs on curves, thus permitting of coupling a considerable number of driving wheels; this is accomplished by boxes mounted on the crank pins of the middle wheels of each frame, which are adapted to slide in the direction of the length of the pins. Fig. 1 is a perspective view of a locomotive embodying these principles; Fig. 2 is a plan view of the joint; and Fig. 3 is a plan view of the locomotive supporting frame and the truck frames.

The platforms of the locomotive and tender—the latter is not shown in the engravings—are supplied with pivots V' for supporting them on four frames A, in the middle of which the pivots are arranged. These frames are supported by pivots on trucks formed of the platform B, supported by springs from the axle-boxes. On the bottom of the box is a frame B², in which are journalled the shafts carrying the small guide wheels E, the load being so distributed as to rest entirely on the axle C, and not on the guide wheels. The axle under each pivot is provided with fixed wheels, and is so arranged that it can slide laterally in its bearings. The cylinders are united by connecting rods L with the crank pins L', on those wheels that are mounted on the axles between the wheels under the pivots V', so that motion is transmitted by rigid connecting rods. The motion is then transmitted to the other wheels by extensible connecting rods. The automatic lengthening and shortening of the connecting rods can be accomplished in various ways, one of which is shown in Figs. 2 and 3. A sleeve G, Fig. 2, is mounted on the crank pin in such a way that the pin can revolve within the sleeve, on which are triangular frames H on diametrically opposite sides. The shank J of the frame passes through a diagonal slot in the sliding block B, sliding longitudinally in a box E mounted loosely on the sleeve, and which slides in the direction of the length of the sleeve. A box is formed with slots D, through which the diagonal shank of the frame passes. The connecting bars A are pivotted to the sliding blocks, and the outer ends of the boxes are pivotted by ball-and-socket joints to the bent ends of the shafts U, Fig. 3.

FIG I

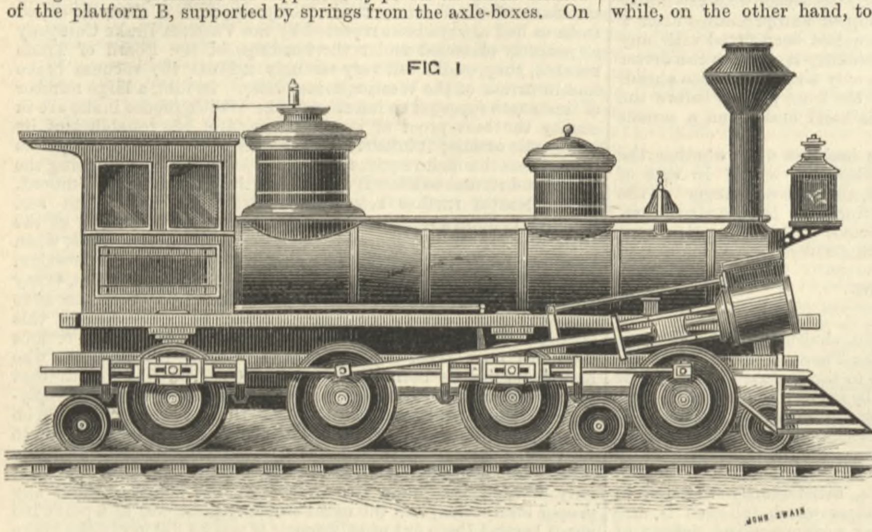


FIG.2

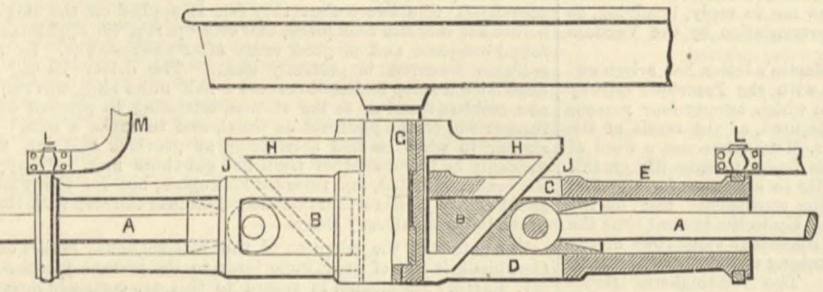
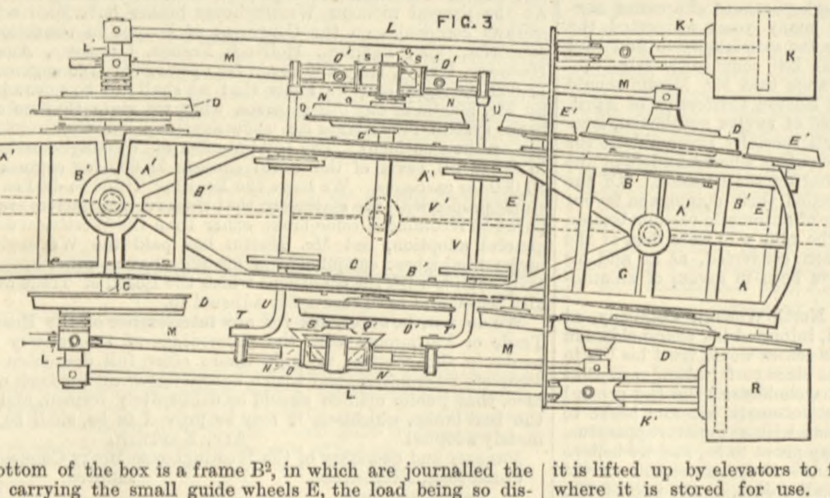


FIG.3



When the locomotive runs on a curve, the wheels will be about in the position shown in Fig. 3; the wheels of each platform remaining on the track in the usual manner, but the middle axle slides outward toward the rail having the longer radius. Looking at the locomotive from the front, the right-hand connecting rod M, Fig. 3, extending from the front to the rear wheels, will have to be lengthened, and the left-hand rod will have to be shortened. As the axle moves to the right in relation to the platform, the sleeves and their frames will move in the same direction. In the right-hand wheel the inclined arms of the frames press against the sides of the slots in the sliding-boxes, and move them toward the ends of the frames, which, turning on the ball-and-socket joints, lengthens the right-hand connecting rod. At the left-hand end of the axle the frame, acting on opposite sides of the grooves, will draw the sliding blocks toward the middle, thereby shortening the connecting rod. We have not space to describe in detail the other methods by which these results may be accomplished. The locomotive can be built with a single platform, or with two or more platforms pivotted to each other, and the platforms can be made of greater or less length, according to the curves on the road. By coupling several driving wheels, the traction is increased—a point of great importance in locomotives running on mountain railways.

A NEW GAS-MAKING PROCESS.

IN the early days of gas-making, and even down to a comparatively recent date, the sulphur compounds which accompany the gas on its passage from the retort were to a large extent disregarded, and were permitted to go forth to the public in considerable quantities, imprisoned in the gas, to be released at the point of combustion, there only to produce very rapidly a highly vitiated atmosphere. In the course of time, however, chemical science was brought to bear upon the subject, and gas referees were appointed who should, and do, exercise authority in this matter over the gas manufacturers of London. The London companies have been made subject to penalties if the quantity of these sulphur compounds exceeds a certain minute fraction per 100ft. of gas, so they have to eliminate them as far as possible by purifying the gas before it leaves the works. But in doing this another difficulty is encountered. The only means of arresting these compounds is by the aid of lime purifiers, and these have to be frequently cleaned out, sometimes once a week and sometimes more frequently, according to the make of gas. This cleansing operation forms the basis of an indictable nuisance, for the foul smell of the sulphuretted hydrogen proceeding from the purifiers pollutes the air for a considerable distance in the direction of the wind. The gas manufacturers are thus placed on the horns of a dilemma; to leave the sulphur compounds in the gas, beyond a certain infinitesimal proportion, is to expose themselves to the ire of the gas referees and a heavy fine, while, on the other hand, to take them out is to lay themselves open to an indictment for a nuisance in the neighbourhood of their works, as they have found by disagreeable practical experience and to their cost. Lime being the only known means whereby the sulphur compounds could be arrested, it has occurred to several experimenters from time to time to put lime in one form or other into the retorts with the coal. But until the present time they do not appear to have carried out the idea to any approximately satisfactory conclusion in practice. It has now, however, been done by Mr. W. J. Cooper, whose coal-liming process is in use at the Tunbridge Wells Gas Works, where we recently witnessed its operation. It has been working there for the past ten months with perfect success, having been introduced by Mr. R. P. Spice, the consulting engineer to the gas company, and started on October 31, 1883. To Mr. Cooper belongs the credit of working out and determining the proper proportions and method to be observed in order to render the system, not only practicable, but profitable. By his process pure gas can be obtained, a public nuisance avoided, and an extra profit secured to the gas company. The process consists simply in mixing 2½ per cent. of lime with its own weight of water, and adding it to the coal, thus giving 5 per cent. by weight of the quantity of coal to be carbonised. In other words, 1 cwt. of lime and water is mixed with every ton of coal and charged with it into the retort.

The Tunbridge Wells Gasworks, which adjoin the South-Eastern Railway, produce 110,000,000 cubic feet of gas annually, which means the carbonisation of about 10,550 tons of coal. The coal is brought in by the railway trucks and tipped into the stores, the lime being dealt with in the same way. The coal used is New Pelton, with 2½ per cent. of Cannel coal. In the stores, which, of course, adjoin the retort-house, the coal and moist lime are mixed in the proportions already given, and are fed into an incorporating mill, in which they are pulverised and blended by passing between a pair of toothed rollers. The limed coal falls into receivers, from whence it is lifted up by elevators to fixed hoppers in the retort-house, where it is stored for use. From these hoppers the coal is drawn off as required into West's charging apparatus, and fed thence into the retorts. There are sixteen benches of retorts, having six mouthpieces in each, and West's apparatus, which runs on rails in front of the retorts, can be elevated or lowered to charge the retorts at any level. By this means the severe and degrading manual labour attending retort-charging is very greatly reduced, and upon humanitarian principles Mr. West's invention is to be commended. From the retort the gas passes to what is known as the St. John carburetting apparatus, by which means the formation of naphthaline is prevented, this troublesome substance always being produced when working at high heats—as is the practice at Tunbridge Wells—and choking the gas apparatus at one point or other, being very capricious in its choice of location. A steam jet exhauster, by creating an induced current, forces the gas to the condensers, which, by means of an internal pipe, can be warmed in winter and cooled in summer if necessary. From the condensers the gas passes to the scrubbers, where it is washed by meeting a current of falling water, which extracts the ammonia from it. From the scrubbers the gas passes on to the oxide of iron purifiers, of which there are six, but only two in use. From thence the gas is conducted to the gasholders, of which there are two on these works. It will thus be seen that lime-purifiers are entirely dispensed with. Moreover, the oxide of iron purifiers have not been opened for about ten months, and it is stated there is every reason to believe that they will last another ten months, or even more, without being opened. With the ordinary process of gas-making, the oxide purifiers at Tunbridge Wells used to be opened once every ten days, and the lime purifiers once a week in winter. A double nuisance is thus avoided as well as an expense.

With regard to the question of gain to the company, this extends beyond the labour and expenses attending the frequent opening and removing the purifiers. The limed coal process results in an increased yield of ammonia and of tar. At Tunbridge Wells the company convert their ammoniacal liquor into sulphur of ammonia themselves. The ammoniacal liquor is conveyed from the store tanks to stills, where it is distilled over into evaporating tanks heated by steam coils. The sulphate is removed as it is formed, and is drained and stored, being sold for chemical and agricultural uses. The company find their gain in this item to be about 30 per cent. by the the Cooper process. Another point for notice is the improved character of the coke produced, which is entirely free from sulphur. This appears at first sight singular, for, as the sulphur does not pass over with the gas, it might be expected to remain in the coke. And so it does, but in a chemically altered condition, so that when the coke is burned the sulphur, instead of being given off as a gas in combustion, is thrown down as a solid in the ash. This absence of sulphureous vapour was demonstrated by a clear-burning coke fire, in the products of combustion from which we were unable to detect any sulphur fumes whatever. On the whole, then, it appears to be practically demonstrated that Mr. Cooper's invention is a step in the right direction, the results being in favour of gas companies from a monetary, and of the public from a sanitary, point of view. These two important advantages should, and doubtless will, lead to a wide adoption of the process.—*Times.*

ELECTRIC RAILWAYS IN THE STATES.

THE *American Journal of Railway Appliances* contains an article on a new electric railway at Coney Island. Running along the west side of the New Iron Pier, at West Brighton, a track 780ft. long, nearly the whole length of the pier, has been laid. The gauge is 24in. The rails are of T section 8 lb. to the yard, and 20ft. long each. The ends of the rails are laid on a specially made plate, clamps are then put on, and the whole firmly bolted together. To help the conductivity at the joints, these chairs have been reinforced with strips of copper. The rails themselves are laid on strips of wood, and both firmly bolted to the pier planking. No attempt is made at insulation. In fact, none is needed. The generator for furnishing the current is a No. 5, and capable of producing a 6-horse power current. It is shunt wound, with low electro-motive force. The intensity of the current varies, of course, with the external resistance; and obviously upon this resistance depends the speed of the motor. Its normal speed is 1100 turns per minute; its weight about 650 lb. It is driven by one of the New York Steam Safety Power Company's 8-horse vertical engines. The motor is modelled after its famous predecessor, the Ampère, which ran so successfully last winter at Saratoga Springs. The body is made of 2in. ash, is 6ft. 6in. long, and 3ft. wide. The superstructure consists of only a dashboard 20in. high, to which are attached the switches for controlling the motor; a box on the rear, 30in. wide, 36in. long, and 15½in. deep, in which is placed the receiving dynamo; and, in front of this box, and attached to it, the driver's seat. On the right of this seat is the reversing lever for reversing the brushes on the commutators, hence the flow of current through the armature, and thus its direction of rotation; giving either a forward or a backward motion to the motor. The running gear is simply four 12in. wheels, with 4in. centres, firmly attached to the body, and rigidly held in their place. To prevent short circuiting from rail to rail, *i.e.*, from one side to the other, the wheels on one side are specially constructed. An iron flange and an iron hub are firmly bolted to a solid, heavy piece of red oak. The wood effectually stops the tendency of the current to pass from one wheel to its opposite through the axle. The receiver is a "No. 3," and capable of giving from 3 to 4-horse power. It is compound, and its armature is capable of a large number of speeds; and this obviously means speeds of motor. The best armature speed is about 1500. The weight of the receiver is about 450. The energy is transmitted to a counter, bolted up under the body of the motor, and from this to the wheels. The arrangement is double, and the best of belting is used. The governing apparatus is extremely simple. It consists of two handles and the reversing lever. One handle controls the circulating of current in the receiver, and thus the speed of the motor, and the other is the brake switch. These unite in an exceedingly neat manner many combinations, and overcome several very troublesome points—such, for instance, as the heavy flash with its destructive result on breaking an electric current. The brake switch is furthermore so constructed that the driver can only have brakes on while his hand is on the handle.

The passenger service consists of two cars. They are substantially built, are 12ft. 2in. long, 32in. wide, and seat twenty persons each—ten on a side, sitting back to back. This makes a total of forty persons carried comfortably. As high as fifty have been carried; nearly 4 tons in weight. The cars weigh about 400 lb. each. The total weight of the Pacinotti is 1200 lb.; its maximum speed from twelve to fifteen miles an hour.

This season will give the Daft system a thorough test as regards safety, durability, and trustworthiness. Tests will be made upon which to base economical questions. It undoubtedly will prove itself fully capable, and will succeed in demonstrating beyond cavil its practicability.

TENDERS.

WORKS of sewerage and water supply for the Rural Sanitary Authority for the District of Petersfield. Mr. W. Barns Kinsey, M. Inst. C.E., Westminster, engineer.

	£	s.	d.
Thomas Hall, Portsmouth	8757	6	6
Bottom Bros., Battersea	7976	0	0
T. Crook, Northam	7480	0	0
T. Poole, Gravesend	7385	4	0
T. McKay, Southsea	7118	17	3
Crook and Smith, Southampton	6993	0	0
T. B. Hayter, Landport	6740	0	0
B. Cooke and Co , Battersea	6718	0	0
T. Adams, Moorgate-street	6437	0	
W. H. Dearle, Eastbourne—accepted	5860	0	

GUN CARRIAGES ON THE MONCRIEFF SYSTEM FOR RUSSIA.—Messrs. Easton and Anderson have just received from the Russian Ministry of Marine an order for hydraulic disappearing carriages, on Colonel Moncrieff's system, to mount a pair of 12in. B. L. R. guns of 50½ tons weight in a fixed turret. The guns are being made at the Abouchoff Works, at St. Petersburg; they will be 30ft. long, will carry 731 lb. shot, and have a muzzle velocity of 1950ft. a second. Seven years ago Messrs. Easton and Anderson fitted similar carriages to the short 12in. guns, of 43 tons weight, on board the circular ironclad Vice-admiral Popoff; the working of these carriages has been so satisfactory that the Ministry of Marine has decided to adopt the system for the new ironclads now building, and the carriages just ordered are to form the pattern or standard from which the rest are to be made.

TURKISH BRIDGES.—Mr. Consul Everett, reporting on the condition of some of the districts comprised in the consulate of Kurdistan, refers to the construction of bridges in the vilayet of Diarbekir, most of which are wooden, though a few are of stone. The Government set aside 150,000 pias specially for the construction of bridges, yet the villages were forced to supply both stone and lime. In the Sandjak of Maden, the officials charged the Government 50,000 pias for the construction of bridges; out of eleven, six have already given way altogether; two on the Aleppo road, said to have cost 18,000 pias, have also broken down, and none of them lasted more than one winter. Generally speaking, also, the roads have been badly constructed, and will have to be improved without delay, in order to render them of any permanent value.

A YEAR'S STRIKES IN NEW YORK.—The disastrous effects of strikes are shown by those which occurred in New York in 1883. There were 44,950 strikers of various kinds during the year, and they lost 366,150 days' work, valued at £125,000 in wages, in addition to the loss to the masters. The chief strikes were those of the cigar and cigarette makers, who lost 163,000 days and £63,100 in wages; the carpet weavers, who lost 77,000 days and £20,000 in wages; the building trades workmen, who lost 25,000 days and £19,000 in wages; the telegraphists, who lost 34,500 days and £15,000 in wages; and the silk riband weavers, who lost 11,250 days and £4000 in wages. Only one great strike was successful, that of the Cuban cigar makers, who were but a small proportion of those taking part in the cigar makers' strike, and who obtained an increase of 8s. per week. The telegraphists were defeated, but concessions have since been made to them. Of the less important strikes, only two were successful, those of the compositors and the carpenters. The former gained an advance of 8s. per week. The year 1883 was memorable in New York for the number of its strikes, but the results achieved bore no proportion to the sacrifices involved by the various trades.

THE DEFEAT OF THE BRUSH PATENTS.

"THE action," says an American contemporary, "which was brought in the United States Circuit Court of the southern district of New York, on Dec. 3rd, 1880, by Charles F. Brush and the Brush Electric Company, against C. H. Condit and others, now represented by the United States Electric Lighting Company, has been dismissed by Judge Shipman. It will be remembered that the complainants alleged an infringement by the defendants of two separate patents granted to Mr. Brush, one for metal-plated carbons and the other for the well-known ring-clutch movement employed to regulate the carbons in the Brush arc lamp, a device which was asserted to have been used in a large number of the Weston arc lamps made and sold by the defendants. The suit has been pending nearly four years, and a vast mass of evidence has been taken on both sides. The record, including the testimony, exhibits, and arguments of counsel, occupies some 2500 printed pages, the 'brief' filed by the complainants' counsel alone comprising no less than 448 pages. The case was argued before Judge Shipman at Hartford by consent of counsel in March last, the hearing occupying eight days. The judge has now decided that the claims of the 'clamp patent,' properly construed, are not anticipated by the well-known English lamp of Slater and Watson, embodying a very similar mechanism, which was set up as a defence, but that a lamp constructed in 1876 by one Charles H. Hayes, an employé of Wallace and Sons, of Ansonia, Connecticut, did, in fact, embrace a construction and mode of operation substantially the same as that claimed as new in the patent of Brush, and therefore furnishes a complete anticipation of such claims. The complainants contended that the lamp of Hayes was an abandoned experiment, inasmuch as but one of them was ever made. The evidence, however, showed that it was practically used in public. The judge says:—'The case is that of the public, well-known, practical use in ordinary work, with as much success as was reasonable to expect at that stage in the development of the mechanism belonging to electric arc lighting, of the exact invention which was subsequently made by the patentee, and although only one clamp and one lamp were ever made, which were used together two and one-half months only, and the invention was then taken from the lamp, and was not afterwards used with carbon pencils, it was an anticipation of the patented device under the established rules upon the subject.'

"The bill for the metal-plated carbon patent was dismissed, with costs, upon the complainants' motion.

"As we have already remarked in relation to this case, no fundamental principle of importance is involved in the decision. The clamp mechanism of Brush, although perhaps the cheapest and most convenient, is only one method among many of effecting the desired result of controlling the movement of the carbons, so that the competitors of the Brush Company, in case the patent had been sustained, would probably have done nothing more than alter their mechanism at a comparatively small expense and go on with their business.

"But the result of the litigation must nevertheless have been severe disappointment to the complainants, at they appear to have confidently expected a decision in their favour, and in that event would, at least, have been able to collect a large amount of royalty from their competitors on account of past infringement upon the patents, even though some other device not covered by the patent should hereafter be substituted by them for the ring-clutch. Inasmuch as the Hayes mechanism was never patented at all, this decision virtually makes the ring-clutch movement of the arc lamp public property. An appeal to the United States Supreme Court will doubtless be taken by the complainants, although in view of the circumstances of the case as developed in the testimony taken by the defence, there would seem to be but little reason for them to hope for a reversal of the decision of Judge Shipman. If the decision had turned upon the question whether or not the defendants' apparatus was an infringement of the patent, the prospect might have been very different, but it really amounts to a question of fact as to the public knowledge and use of the Hayes lamp, and upon this point it is not very likely that the Supreme Court can come to a different conclusion from the Circuit Court.

"The claims of the Brush patents on electric light apparatus are many of them of such a broad and sweeping character, that if sustained they would have gone far to ensure to the Brush Electric Company a virtual monopoly of arc lighting, but the unexpected strength of the defence, and the able and thorough manner in which it has been developed, has now practically destroyed two of the patents, and thus materially weakened the position of that company.

"It now seems probable that the comparative future progress of the principal arc lighting companies will depend much more on the actual merits of the apparatus presented to the public than upon the results of litigation which may hereafter take place between them, a result at which the public at least can have but little occasion to complain."

DOMESTIC ELECTRIC LIGHTING.*

By MR. W. H. PREECE, F.R.S.

THE author commenced by expressing his surprise that he had seen only one example of domestic electric lighting in Canada. Sir W. Thomson had been the first in England to do this, and others, fired by his example, had followed suit, himself being one of these. The object of Mr. Preece had been to find out what trouble and difficulty would be entailed as, though there were estimates to be had in plenty, which were themselves no doubt honest, these did not represent the whole aspect of the question. He had built in his garden an engine house, and had placed in it a 2-horse power gas engine and dynamo, the current from the latter being 36 ampères, with an electro-motive force of 42 volts., and therefore 1512 Watts, or about 2-horse power as the result, which showed a very high efficiency. This current goes into secondary batteries, and the gardener, when he comes on duty, merely starts the gas engine and charges the cells, but Mr. Preece now proposes to have a sufficiently large battery to enable the charging to be done only once a week. The author then proceeded to give an account of various special features in the lighting of his house, and of a portable lamp which he employs. The actual cost per lamp was £7 10s., and he considered that, although the actual cost was perhaps, when working, twice as much as gas, yet the fact that from the great convenience of its use it was only employed from one-half to one-third of the time, and caused no trouble, it was greatly to be preferred. He spoke of the great hindrance to the progress of electric lighting by the most unfortunate Act of legislation which had been enacted for some time, but in spite of this the application was steadily going ahead, and mentioned some of the places in which this was taking place.

Sir W. Thomson, in the discussion on this and the previous papers of Mr. Preece, said it would be vastly more convenient to have a unit of such magnitude of a horse-power, say, about 1000 Watts, instead of dividing constantly by 746, which involved a constant waste of brain power. He spoke very strongly from experience of the benefits of domestic electric lighting, and of the application for the purpose of the water power so plentiful in Canada, and particularly of the Lachine Rapids, which were so close to the town of Montreal. He also emphatically endorsed what Mr. Preece had said with reference to the injurious effect of present legislation with regard to electric lighting. Professor Geo. Forbes and Mr. W. Lant Carpenter both continued the discussion, the latter stating that a friend had lighted his house with ninety incandescent lamps at a cost of £360, which was at considerably less cost than Mr. Preece had expended, the reason being that water power from the Teviot Valley had been employed. Sir Frederick Bramwell said that in Mr. Preece's house 28 cubic feet of gas per hour had produced a light of 128-candle power, whereas if the gas had been actually burnt to produce light, only 84-candle power would have resulted.

* British Association.

THE CONGO STEAMER LE STANLEY.

THE following is from a report by Mr. Henry M. Stanley on the performance of the stern-wheel steamer which was built in floatable sections in the early part of 1884, by Messrs. Yarrow and Co., for L'Association Internationale du Congo. It was illustrated in THE ENGINEER of the 1st February last:—"Le Stanley arrived at the Congo from England about the same time that I arrived at Leopoldville from the Stanley Falls. By the time I reached Vivi the sections had been screwed up, engines and boilers with hurricane deck mounted, and within four days I was much gratified to see her one morning steaming up in view of Vivi Station. No one could make her out for a time, and it was very amusing to hear her character guessed at by the crowds which lined the verge of Vivi Cliff. Some laughingly thought that she must be some strange fabric of Portuguese build destined to bombard Vivi, others thought that she must be an English structure sent out by a Conservative Government to settle the Congo question, while others again predicted that she was French—the long-expected gunboat which was to ride over all the Congo Falls to the Upper Congo. As she drew nearer, and we noted the route she took, we became more assured, and finally we saw the flag of the Internationale Africaine Association, and then became convinced she could be none other than the new boat built by Messrs. Yarrow and Co. Though she steamed gallantly up and through the lower Vivi Rapids, which has a current, even inshore, of 8 knots, she had a much more formidable work ahead in the section between Isanjitu and Manyanju, and I wished to test her powers thoroughly before ordering her to be dismounted. The chief engineer demurred slightly at this extra trial, on the ground that she was but temporarily put together; the captain in charge supported him. Notwithstanding their very reasonable objections, I insisted that her powers should be thoroughly tested on the lower river before proceeding to expend £4000 for her carriage overland, and for this test the upper portion of the lower river, which has a current of from 6 to 12 knots, according as you are near shore or in centre of river, was chosen for her run. I also gave orders that she should carry her own steel wagons or trolleys, and all her own extra equipment and stores and planking, so that I could see what she could do heavily loaded in the rapids and whirlpools. She made four round trips of the aggregate length of eighty miles in the worst water of the Congo, in water that whirled the French gunboat Sagittaire, when she attempted to come up to Vivi, round like a top. This work she did, remember, in a state that underwriters would have condemned as being unfair. I then decided that she was fit for our work—that if any accident happened it would be the fault of the navigators and officer in charge. What I admire about her specially is her small draught, her breadth of beam, which gives steadiness and capacity for carrying cargo, and her twin rudders. I was quite astonished at their enormous power. One turn of the wheel instantaneously swept her bow clear of danger that a second before seemed imminent. The boat is an honestly built boat, with honest workmanship and honest material. There is nothing I can criticise except her power of speed, which is only ordinary. As she was destined for the Upper Congo, where the waters are without a ripple and have an average current of $2\frac{1}{2}$ knots an hour, this small power does not greatly matter."

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

(*From our own Correspondent.*)

THE market is just now looking forward with some expectation to the quarterly meetings, which will be held in Wolverhampton on October 8th, and in Birmingham on October 9th. What course prices may then take will depend in some sort upon whether an arrangement is come to with the colliers. The end of this week sees the termination of the period for which the arbitrator's award was made. The employers have not favourably responded to the invitation of the men that they should send certain of their number to consult with representative delegates.

Marked bars will, in all probability, be re-declared at the quarterly meetings at £8 2s. 6d. nominal for the Earl of Dudley's brand, and £7 10s. to £7 for the makes of the "list" houses. Simultaneously all-mine pigs are likely to be re-announced as 80s. for cold-blast sorts, and 60s. to 57s. 6d. for hot-blast. In medium and common class irons, more especially the latter, alike as to finished and raw, prices will have a firmer tone than three months ago; but actual advances upon that earlier date in any but pigs made outside this district and native sheets, together with some common bars, need not be anticipated.

Meanwhile sheets continue to command the best prices, and makers keep busy, not only on local account, but on merchant orders from Australia, South America, and other export markets. It is somewhat singular that while since the opening of the year prices of black sheets in the local market have fallen perhaps £1 per ton, the prices of sheets of the same makers in the London market have not fallen more than about 5s. From local consumers some makers are now refusing to accept £7 10s. for doubles and £8 10s. for lattens. Makers demand £7 12s. 6d. and £9 12s. 6d. respectively. One or two of the Shropshire makers are at present obtaining £8 5s. per ton for 24 gauge delivered in Liverpool, which is equal to rather better than £7 15s. at works.

As indicating the better change which recently has come over the sheet mills, I may mention that a buyer who two or three months ago refused to place an order which he held for a special unusual size of sheets at a quotation of £9 15s. which he received from Shropshire works, now finds himself unable to place the order with the same firm at less than £11 10s.

The plate mills are only quietly engaged, this branch not having as yet participated in the revival. Bars and hoops are in a shade better demand, but the competition of the Warrington makers in the last-named branch is severe. These manufacturers are understood to be selling hoops at £6 5s. delivered Liverpool. Local makers will not accept less than £6 10s. delivered Liverpool, while some ask £6 17s. 6d. Common bars are £6. Gas tube strip is still low in price, and I hear this week of such an exceptional figure being accepted as £5 10s.

The iron roofing trade shows signs of improvement. South America and the Dutch East Indies are satisfactory buyers just now. Among the roofing firms who are busy, Messrs. Morewood and Co., of the Woodford Iron vorks, Soho, are prominent. They have eight large railway station roofs in hand for the Dutch East Indies, and have lately had orders for several good-sized roofs for South America. Other firms of standing in the roofing trade also find an increased demand.

The galvanised sheet makers in other than the roofing branch do not experience much improvement at present, but the better telegraphic reports from Australia, and the decrease of stocks out there, engender a more hopeful feeling. Orders from South America are considerable, and there are indications of the passing away of the depression which has so long prevailed in the South African market.

In Birmingham to-day the galvanisers were a little firmer in price, consequent upon an advance of 5s. being asked for spelter and the stiffer condition of the black sheet trade. They did not, however, meet with much success, favourable specifications being accepted at old rates. Common galvanised sheets, 24 b.g., packed in bundles, were to be had from local works at £12 to £12 5s. delivered Liverpool, though some best firms asked £12 15s. For 26 gauge £13 15s. to £14 was asked for common sorts, and for 28 gauge £14 15s. to £15s. 5s. Superior qualities of the 26 and 28 gauges were in the same proportion. Birkenhead galvanisers are accepting £11 17s. 6d. per ton for 24 gauge, Liverpool.

The extensive new works that are being erected by the Wolverhampton Corrugated Iron Company expect to make a start in about three weeks from now. Competition with local makers will in some measure be increased by the new works of the Birkenhead Galvanising Company, which it was announced on 'Change to-day are more extensive than the old ones, and by reason of their site will be much more economical in their operation.

Makers of bridges, &c., are doing a fair trade with the Colonies. One bridge, the contract for which has been secured by a firm in the Dudley district, and is scarcely yet begun, is destined for the Orange River, Cape of Good Hope. This bridge is to be constructed on the lattice girder principle, and will, it is estimated, contain more than 1500 tons of iron. The same firm has another large contract on hand for Japan.

The pig iron business is rather slack this week compared with the recent activity. The higher prices of vendors have checked further buying. Yet they refuse to court business by giving way. Hematites are 55s. to 56s. delivered for forge purposes, and Derbyshire pigs 42s. 6d.

The recent much needed attempt at organisation in the operative section of the South Staffordshire iron trade has resulted in a resolution by a mass meeting of the ironworkers at Smethwick, "That the time has arrived when an association shall be formed, and shall embrace at least the ironworkers of South Staffordshire, Shropshire, and East Worcestershire, and that we recommend them to form a lodge at each and any of the ironworks in the three counties."

Tanks are in fairly brisk demand alike on home and export account. In the smaller sizes a considerable business is being done with exporters who use them as packing-cases for dry foods, &c.—a purpose for which they answer admirably. The demand for the purpose of house-supply cisterns is increasing.

Steam pumps are moderately active. Makers, however, would be glad of an influx of orders to take off some of the heavy stocks that are on hand. Among the orders lately placed may be mentioned some from the North of Spain, and others on account of the Government railway lines in India. After competition, the contract for the whole of the pumps needed at the new large gasworks in Amsterdam, now being erected by the Imperial Continental Gas Association, has fallen to Messrs. Joseph Evans and Sons, of Wolverhampton. There are in all thirteen steam pumps—for water, tar, ammoniacal liquor, &c.—and all will be the firm's horizontal Reliable pattern. Several of the pumps will each have a capacity of 11,000 gallons per hour, and the remainder a capacity of 4000 gallons each. The tar pumps have a new floating valve and patent reversing gear, and the water pumps are fitted with the firm's rotating valves. Similar pumps are in use at gasworks which have been erected by the Association at Antwerp, Lille, Brussels, and Rouen, while over 100 of them have been manufactured for the London Gas Light Company.

How powerful a case in respect of preferential and other rates have the South Staffordshire traders in the railway rates controversy was well brought out during the session of the Social Science Congress. Mr. Alfred Hickman, the largest smelter of pig iron in this district, and the main promoter of the Railway and Canal Freighters' Protection Association, read to the Economy and Trade Department a paper on "Railway Rates and Canal Tolls as Affecting the Trade of Birmingham and the South Staffordshire District." The rates from this district, he affirms, are higher than from any manufacturing centre in the world to the ports of embarkation. The Staveley district, which is served only by the Midland Company, though 36 miles further from London than Birmingham, can get goods sent there for less money, the rate being—from Staveley, 149 miles, 12s. 6d. a ton; Birmingham, 113 miles, 14s.; and Leeds, 193 miles, 17s. 6d. To make the Birmingham rate proportionate to that of Staveley it would have to be reduced 4s. 6d. a ton, and to that of Leeds, 3s. 9d. per ton. Bright iron wire from Antwerp to Birmingham, *viâ* London, is charged 17s. 4d. per ton, but from Birmingham to London the freight is £1 8s. 4d. Sheet iron from Antwerp to Birmingham is 17s. 4d., and from Birmingham to London 14s. Nails: Antwerp to Wolverhampton, 16s. 4d.; and from Wolverhampton to Harwich, £1 1s. 4d. Iron girders: Antwerp to Birmingham, *viâ* Grimsby, 16s. 8d.; Birmingham to Grimsby, 17s 6d.

The continental rates for hardware are:—France, 2d. per ton per mile; Holland, $2\frac{1}{10}$d. per ton; Austria, $1\frac{1}{3}$d.; Germany, $2\frac{1}{3}$d.; and Italy, $1\frac{1}{2}$d.; whilst from Wolverhampton to Liverpool the rate is 3d., to Sheffield 4d., and to Liverpool 4d.

The utilisation of cinder from the puddling furnace in the manufacture of Bessemer basic steel is a mode in which, in the view of Mr. R. Smith Casson, the general manager of Lord Dudley's Round Oak Ironworks, much economy may be effected in the utilisation of waste products. The suggestion was laid before the Social Science Congress in Birmingham this week, and is canvassed with a good deal of interest by the trade.

Certain employers in the nut and bolt trade of Darlaston and Liverpool having endeavoured recently to enforce reductions, although members of the Employers' Association, the Executive Council of the Nut and Bolt Makers' Association at a special meeting in Birmingham have deprecated the action, and advised the Council to resist. The events complained of in the South Staffordshire district were left with the Darlaston Committee; and it was agreed that the men on strike at Liverpool should be supported, and that in all such cases the whole of the men be instructed to give in their notices and cease work if other men were discharged. The application of the nut and bolt makers of Sheffield to be re-admitted into the Association was granted.

The courses of mining lectures given at Mason's College, Birmingham, are considered important. The Board of Examiners for granting Government certificates to mine managers in South Staffordshire have, it is understood, determined that in future candidates must have attended them before sitting for the examinations.

It has been roughly estimated that an expenditure of about £10,000 will be needed upon sewerage, pumping, and other works to put the sanitary arrangements at Kidderminster into perfect order.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester—Although there is little or nothing in the actual condition of the market to justify the conclusion that there is any real improvement in trade, a stronger tone is maintained, and a better feeling appears to prevail. Makers ars not disposed to entertain the low offers which were accepted a few weeks back, and it would be difficult to place orders for some brands of pig iron within 6d. or 1s. per ton of the lowest prices taken recently. There has been a moderate weight of business doing at the low rates, and makers are now endeavouring to get better prices, but it is only on small parcels that consumers are absolutely compelled to place out that any advance is obtainable. In view of the generally settled conviction that prices have touched their lowest point, buyers in some cases would be disposed to pay a slight premium upon the minimum rates for long forward contracts, and for delivery well over next year a tolerably large business might be done. But makers are very chary about committing themselves very far ahead; in some cases they decline to go beyond the end of the present year, and it is very exceptional when they will go further than the first quarter of next year; but so far as present business is concerned very low prices have to be taken to secure orders. In the finished iron trade orders are reported to have been coming forward more freely, and this has had a tendency to give more firmness to prices. Any upward movement in the market is, however, overshadowed by the generally depressed condition of trade, and the continued want of strength shown by the North of England iron trade, notwithstanding the restriction of the output, operates strongly upon buyers in encouraging them to resist any attempted advance in prices.

A rather better tone characterised the Manchester iron market on Tuesday, and in some cases sellers were holding out for a slight advance in prices; but where business was done it was on about the basis of late rates. Lancashire pig iron makers have been booking orders rather more freely, and they are disposed to be somewhat firmer in their prices; but 41s. to 42s., less 2½, is still being taken for forge and foundry qualities delivered equal to Manchester. Some of the district makers of pig iron are now fairly well sold for their present limited output, and 42s. to 42s. 6d., less 2½, represents about the minimum basis for delivery into this district, with some of the better qualities of Derbyshire iron quoted at 1s. to 1s. 6d. per ton above these figures.

Hematites continue bad to sell, and there are good foundry brands in the market to be bought readily at about 53s. 6d., less 2½ delivered into this district.

For manufactured iron there are more orders stirring, and makers are very firm at £5 12s. 6d. as the minimum they are open to take for good qualities of Lancashire or North Staffordshire bars delivered here, with quotations in some cases advanced to £5 15s., and common bars are becoming difficult to get at as low as £5 10s. per ton delivered into this district.

In the engineering trades a slackening off in the weight of new work coming forward continues to be reported, and machine tool makers are in some cases getting short of orders.

I was at the works of Messrs. William Muir and Co., of Manchester, the other day, and noticed a number of specially designed machine tools they have in hand for locomotive and other purposes. In profile milling machines, there was one of very large size, specially designed for the connecting rods on Mr. Webb's new compound locomotive, which has been constructed for the works at Crewe. This milling machine will work up to 9ft. long, 15in. wide, and 6in. deep, and combines all the latest improvements, being self-acting in all directions, with self-acting chuck for bosses of levers, &c. In the straight milling machines, one is being made to mill a surface 15in. wide, and 10ft. long, and is of massive construction, the spindle being 5in. diameter. A number of Hure's new patent milling machines are also being made by Messrs. Muir. The novelty in these machines is that they have two spindles, one horizontal, and the other vertical. By this arrangement almost any variety of milling work can be accomplished, and the change from horizontal to vertical milling is effected almost instantaneously. Two of these machines have been made with a range of 40in. horizontal traverse. A number of vertical drilling machines, with steel spindles of 2½in. diameter, have just been finished for the new works of the North-Eastern Railway Company. In these machines an improvement has been carried out which consists in the driving gear being so arranged, that instead of the cone pulley being longitudinal with the body it is placed at right angles, and by this means the machines can be fixed to work in line with other tools, an arrangement which possesses the important advantage that it effects a considerable saving of space. These machines have also a releasing motion to the spindle, which enables it to be brought to its work or withdrawn quickly. A horizontal boring, drilling, and tapping machine has been made for Messrs. Jones and Co. of Liverpool, the special feature of which is in the arrangement of the tapping and studding, the machine being capable of completing a stud 1in. diameter in five minutes—that is, the hole can be drilled, tapped, the stud screwed home, and then cut off in the space of time above mentioned. A 54in. lathe, differing only in detail from the one recently made for the English Government, has just been completed for Russia. This machine, which is of massive construction throughout, with a bed 49ft. in length, has quadruple gearing and four carriages, each acting independently in the longitudinal and transverse motions, whilst, in addition, each pair of carriages can be worked by a steel screw 5in. diameter.

Messrs. B. and S. Massey, of Openshaw, near Manchester, have at their works a novelty in steam hammers, which has been constructed from special designs for Messrs. Tangye Bros. This consists of a double steam hammer or two steam hammers with combined framing fixed upon the same base plate and anvil block. This arrangement enables one man to have complete control over both hammers simultaneously, whilst they can also be worked by one lad. The hammers have a falling weight of 7 cwt., and being carried in one frame they are very compact in arrangement, the space between the hammers being only about 4in. Each hammer can be worked independently and at any speed according to the nature of the work. Apart from the special combination which has been carried out in a very neatly designed framework, the double hammer is in other details similar to the single hammers made by the firm.

In the coal trade business continues dull for the time of the year, and comparatively few of the collieries have as yet been able to go on full time, the average, to a large extent, being still about four days a week, with stocks going down at many of the pits. The recent mild weather has kept back any pressure for house fire coals, and other classes of fuel for iron-making, steam, and general trade purposes, are only in moderate demand and plentiful in the market, with common slack a drug. With the exception that slack is rather easier, prices remain without change, best coal averaging about 7s. 9d. to 8s.; seconds, 6s. 9d. to 7s.; common round coals, 5s. 6d. to 6s.; burgy, 4s. 6d. to 5s.; good slack, about 4s.; and common sorts, 2s. 6d. to 3s. per ton.

In the shipping trade the demand shows a falling off, with 7s. 3d. per ton about an average figure for good Lancashire steam coal delivered at the high level, Liverpool, or the Garston Docks.

The threatened strike in the Ashton and Oldham district has been averted by the colliery proprietors having withdrawn their notice to terminate contracts, and the men are working on at the old rate of wages.

Barrow.—The hematite pig iron market of this district is still lacking activity, as can only be expected in view of all the conditions affecting the general trade of the country. The prospects of an improvement are, perhaps, a little brighter, but no real change in favour of makers has yet occurred. The demand from all quarters is, I understand, very limited, and consumers, although prices are in their favour, do not speculate, but rather restrict business, and purchase only for immediate requirements. The depression in the steel industries seriously affects this trade. Quotations this week are unchanged, mixed Bessemer samples being priced at 43s. per ton net at works, prompt delivery, and No. 3 forge at 40s. 6d. per ton. The number of furnaces now in blast is not reduced, and the output is well maintained. Steel makers are securing a good share of what is offering; but this is nothing like sufficient to keep them steadily employed. At Barrow the works are again closed this week, makers going on the principle of working for two or three weeks, and then stopping one. No new orders of extent have been booked for rails, and the present deliveries are far below the average. Ordinary sections are quoted at about £4 15s. per ton. Merchant qualities and hoops are perhaps selling a little better. Shipbuilders are expecting to receive further orders. Iron ore is quiet at prices ranging from 8s. 6d. to 9s. 6d. per ton. Stocks are heavy. Shipping dull. Coal easier.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Messrs. James Dixon and Sons, the well-known silversmiths, of Cornish-place, Sheffield, did a smart piece of work for the Government last week. On the 10th inst. they received an order for 6090 table-spoons for the use of the troops in the Nile expedition. On the 13th—Sunday intervening—the goods were finished and packed off. The metal had to be made, and, as Sunday has to be taken out of the working days, the order was completed—metal-making and all—in three days. In four days Messrs. Dixon and Sons had orders for no fewer than 27,000 spoons and forks, one order alone being for 1546 dozen, making 18,552 spoons. The quantity of spoons needed by the world can only be equalled by its pins.

The value of a trade mark had singular proof in a Sheffield saleroom this week. Mr. Robert Marsden, of the Tinsley Park Ironworks, offered "The Elephant Nonpareil," a well-known trade mark, which has been registered by the Cutlers' Company, and under the Trade Marks Registration Act in Classes 5, 6, 7, 12, and 13, embracing the whole of the Sheffield trades. It has also been registered in Germany, and is stated to be well-known in the United States and India. The different classes of goods embraced by the mark are as follows:—Class 5, iron and steel and steel wire; Class 6, machine knives (not being parts of agricultural machines); Class 7, agricultural machine knives; Class 12, cutlery and edge tools generally—files, saws, scythes and shears; and Class 13, metal goods not included in other classes, and not having a cutting edge, except hoes, spades, shovels, and ship scrapers. There was keen competition between Messrs. W. Tyzack, Sons, and Turner, steel refiners and manufacturers of saws, files, scythes, and machine knives, Little London Works, and Messrs. Moss and Gamble, merchants and manufacturers of steel, files, saws, edge tools, &c., Franklin Works. The mark was put up at £100, and advanced slowly to £160. From this point competition was very keen, and the mark ultimately became the property of Messrs. W. Tyzack, Sons, and Turner, for £580.

Two collieries in this neighbourhood have been the scenes of alarming fires—the Alma Colliery, North Wingfield, near Clay Cross, on Friday, and the Wharncliffe Carlton, where the sad disaster took place a year ago. At the latter place, a fire was found in an old engine house about 50 yards from the bottom of the pit shaft. The men were withdrawn from the pit, and from the adjoining East Gawber pit, and the Barnsley Fire Brigade sent for. After several hours' labour the fire was extinguished. The engine-house was a structure from which the engine was taken two years ago, and the fire must have been smouldering behind the brick archway for a long time, and had been fanned by currents of air which somehow or other had got to it. At the Alma Colliery a fire broke out in the lamp office. Some 500 lamps—several of them new, which had never even been used—were placed there. The lamp cleaner was engaged filling the lamps ready for the day shift men, when the oil—called "conzoline"—caught fire from his light, and the whole building was quickly enveloped in flames. Walker and his boy escaped with only a few slight burns; but the office and its contents were soon reduced to ashes, and two pits were thrown off work. The colliery is the property of Mr. Thomas Holdsworth, of Clay Cross.

The Rotherham jury have concluded their inquiry into the circumstances of the accident at the Phœnix Bessemer Steel Works—Messrs. Steel, Tozer, and Hampton—whereby three men lost their lives on the 10th inst. by the capsizing of a ladle containing over seven tons of molten metal. The jury made a most exhaustive investigation, and then regretted they could not do more. The coroner took occasion to comment on the practice which, he said, evidently existed in the minds of some of the jurymen, and intimated that he would send the case before a judge if they did not agree. They would then have to appear at the Assize Court. Ultimately the jury returned an open verdict, adding an expression of regret that there was not more scientific evidence before them.

Messrs. Joseph Rodgers and Sons, the well-known cutlery house of No. 6, Norfolk-street, Sheffield, have been awarded the first prize gold medal for their exhibits of cutlery at the International Exhibition at the Crystal Palace.

We are now close upon October, but I hear of no movement on the part of the miners in regard to wages. The coalowners are still advertising "lowest summer prices," and in spite of a change in the weather, the demand is not equal to the supply. Steam coal also keeps very quiet.

A most successful substitute for ivory has at length been discovered. It is called "ivoride," and in touch, appearance, and transparency resembles the fine qualities of the elephant's tusk it is intended to replace. A table-knife, with a handle of ivoride, was shown to me the other day. Sixteen years' residence in Sheffield has given me some knowledge of ivory, but I was quite deceived by the knife, which seemed to me to be ivory-handled. None but experts could really detect the difference between ivory and ivoride, which, I may add, is produced by Messrs. Joseph Rodgers and Sons.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

The Cleveland pig iron trade has been steady for several days. At the market held at Middlesbrough on Tuesday last merchants would not accept less than 36s. 6d. per ton for No. 3 g.m.b., which is equivalent to an advance of 1½d. per ton on the price of the previous week. They could however offer only small lots, as makers hold almost all stocks, and No. 3 is difficult to obtain. Most of the makers are well sold for next month, and they will not take less than 37s. for No. 3, and in some cases they are even able to obtain 37s. 6d. per ton. The business done on Tuesday was mostly for prompt delivery. There is a strong feeling that prices will be lower when the shipping season closes. For forge iron makers still ask 35s. per ton, but the quantity offered is greatly in excess of the demand, and it can readily be bought from merchants at from 33s. 9d. to 34s.

Warrants are unsaleable at 36s. 3d. per ton.

The stock of pig iron in Messrs. Connal's store at Middlesbrough on Monday last was 55,039 tons, being a reduction of 486 tons for the week. At Glasgow their stock has decreased 685 tons, the quantity now held being 584,202 tons.

Exports of pig iron from the Tees continue large. The quantity sent away up to Monday last was 66,371 tons, being about 10,000 tons more than during the corresponding portion of August.

Orders for finished iron are scarcer than ever. None of the mills are now running full time, and some have been closed altogether until such time as the demand improves. Prices are not altered. Ship plates are offered at £5 per ton, angles at £4 15s., and common bars at £5 2s. 6d., all on trucks at makers' works, cash 10th, and less 2½ per cent.

Several thousand operatives are still idle at the Hartlepools, Stockton, Middlesbrough, Sunderland, and Tyneside. It is the same throughout the colliery districts and the mining villages of Cleveland. The distress is very great, and prospects for the coming winter are most alarming. Two or three marine engineering firms on the Tyne are busy, and likely to be so until the end of the year. But this industry will no doubt become more and more depressed unless and until shipbuilding revives. Messrs. Wake and Sinclair, of Low Quay, Sunderland, have finished four of the eight boats they contracted to supply for the Nile Expedition, and the remainder will be ready shortly. Messrs. Palmers' Snipbuilding Company is preparing to manufacture steel plates. They expect to receive further orders for gunboats from the Government. Messrs. Bolckow, Vaughan, and Co. are progressing with the alterations to their plant at Eston, and will soon be in a position to turn out steel plates and steel sheets. The new department will employ about 200 men.

Messrs. Armstrong, Mitchell & Co's new steel works, which are being erected at Low Elswick, are being pushed on towards completion, and it is expected that they will be ready for work before the end of the year.

Freights are reported to be somewhat better from the Wear, and other East Coast ports, and several new vessels which have been laid idle since they were launched, have now left for their first voyages.

A circular has been issued announcing that a club for the insurance of "well-decked" steamships will be started at South Shields early next year. The definition given of well-decked vessels is as follows:—"Those with a raised quarter deck not less than 2½ft., joined to a bridge of ordinary height with an iron front thereto, and also a raised decked forcastle, or vessels with long full poop, covered-in bridge with iron front, and also a raised decked forecastle." It is proposed that at the beginning the line on each steamer shall be £2000.

According to the accountant's returns, issued last week in connection with the finished iron trade, the average net selling price of manufactured iron during the two months ending August 31st, was £5 3s. 11d. per ton. This is a decline of 1s. 6d. per ton since the end of June, and 14s. since the beginning of the year. In July, 1879, the average price was £5 3s. 3d. per ton. The present price is therefore only 8d. per ton more than it was at the worst period of 1879. There is also a marked falling off in the production.

An important meeting of the Board of Arbitration was held at Darlington on the 19th inst. It was preceded by a meeting of the Standing Committee. There were two main questions for consideration independent of each other, and yet closely connected. The first question was what rate of wages is to be paid after the 27th inst. In other words, shall the employers' notice of 5 per cent. reduction, or the operatives' notice of 5 per cent. advance, take effect then, or some intermediate rate? The second question was whether a sliding scale could be framed, satisfactory to both sides, so as to avoid the now perpetually recurring arbitrations. The last question was taken first. On behalf of the employers, it was clearly and definitely announced that no scale less favourable to them than Dale's scale of 1s. 6d. above shillings for pounds, and without either minimum or maximum, would be entertained. On behalf of the men, it was stated with equal firmness that 2s. above shillings for pounds was the lowest they would consent to. They also had come to the decision to insist no longer on a minimum or maximum. They were willing, however, to leave the difference between their scale and the employers to be adjusted by an arbitrator. After a brief consultation the employers declined to go to arbitration upon the terms of a scale, saying they would rather have no scale at all than run the risk of having to accept a higher basis than they had already named. All idea of a scale may, therefore, be considered to be given up for the present.

Under these circumstances, and with the ground thus cleared, the settlement of the wages for the immediate future was taken up by the board. The employers stated their willingness to abandon half their claim for the present, and until Mr. Waterhouse's ascertainments justified it, on the principle of Dale's scale, provided one half now, and the other half when so due, were given without arbitration. Otherwise they would claim their full 5 per cent. The operatives declined this offer, preferring an arbitration on the original claim and counter claim. Dr. Spence Watson was then unanimously selected as arbitrator. The employers proposed that the settlement should be for four months certain, and thenceforward indefinitely, subject to a month's notice on either side. The operatives, however, would not hear of more than two months, and that period was eventually agreed to.

Notices have been received by the creditors of Messrs. Coulson and Co., bar-makers, of Spennymoor, asking them to attend a meeting to consider the financial affairs of the firm.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The pig iron market was very strong up to the end of last week, when warrants advanced to 42s. 0½d. cash, a figure they had not touched for a considerable time back. There has since been a slight reaction in the speculative quotations; but the values of makers' pigs have been well maintained, and in some cases brands which were stationary have shown an advance.

The shipments were not quite so good, amounting to only 11,021 tons, as compared with 13,167 in the preceding week, and 14,338 in the corresponding week of 1883. Connal's stocks show a reduction on the week of 390 tons, and the amount of the production is practically unchanged.

Business was done in the warrant market on Friday at 41s. 10d. to 42s. 0½d. cash, and 41s. 11½d. to 42s. 3½d. one month. Monday's business was at 42s. to 41s. 11d. cash, and 42s. 2½d. to 42s. 1d. one month. On Tuesday the market was quiet, with business at 41s. 10d. cash. Business was done on Wednesday at 41s. 9d. to 41s. 7d. cash; while to-day—Thursday—transactions occurred at 41s. 7d. cash, and 41s. 9d. one month.

The quotations of makers' iron, which are again advanced this week, are as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 56s.; No. 3, 51s.; Coltness, 60s. 6d. and 52s. 6d.; Langloan, 58s. and 52s. 6d.; Summerlee, 54s. and 47s. 3d.; Calder, 53s. and 47s. 6d.; Carnbroe, 51s. and 47s.; Clyde, 48s. 6d. and 45s. 6d.; Monkland, 44s. and 40s. 9d.; Quarter, 42s. 6d. and 40s. 6d.; Govan, at Broomielaw, 43s. 3d. and 40s. 9d.; Shotts, at Leith, 54s. and 52s. 6d.; Carron, at Grangemouth, 49s. (specially selected, 53s. 6d.), and 48s.; Kinneil, at Bo'ness, 43s. 6d. and 43s.; Glengarnock, at Ardrossan, 50s. 6d. and 43s. 6d.; Eglinton, 45s. and 41s. 6d.; Dalmellington, 47s. 6d. and 43s. 6d.

The first outcome of the resolution of the directors of the Monkland Iron Company to reduce their working expenses, owing to the unfortunate position in which they find themselves financially, is the discharge of about 300 ironstone miners. There is a large stock of ironstone belonging to the company awaiting use, and it has been resolved not to raise any more until it has been utilised.

The iron and steel manufactures exported from Glasgow Harbour in the past week are valued at about £68,000.

Considerable interest is felt in Lanarkshire in the reference of the proposed reduction of 5 per cent. in wages in the North of England to arbitration. The practice here has been to follow the example of the North of England in the regulation of wages; and although this was objected to strongly at the time of the last reduction, it is likely that the practice will be adhered to as far as the employers are concerned. In the present condition of trade this practically means that the employers' views will be carried into effect.

Operations have just been commenced by the Belhaven Iron and Steel and Patent Nail Company, who have erected works at Wishaw. The workshops are well supplied with machinery for the manufacture of steel nails, the demand for which has within the last year or two greatly increased.

Messrs. James Goodwin and Co., of Motherwell, have secured the contract to build, mostly of steel, a section of a large bridge, which the East India Railway Company intend constructing over the River Hooghly. It is stated that this contract will furnish employment for the workmen employed by the firm during the next eight months.

The rivetters in the different shipbuilding yards at Port Glasgow have agreed to work at the reduced pay of 8s. 6d. per 100 rivets.

In the coal trade there is a fair business passing. At Glasgow the shipments have been good, including cargoes of 2150 tons for Bilbao, 1690 for San Francisco, 1485 for Santander, 1460 for Bordeaux, and 1171 for Naples. There were 8979 tons shipped at Grangemouth, 7776 at Ayr, and 6590 at Troon, fair quantities also leaving the other shipping ports. Merchants report that in some districts they are now receiving rather better orders for domestic consumption, and they are beginning to arrange with the coalmasters for winter supplies.

Messrs. Gardner, of Meiklehill Colliery, Kirkintilloch, have reached the Kilsyth coking coal seam in a new pit they have been sinking for the past two years, and found it 3½ft. in thickness, and of excellent quality. Their mineral fields here extend to about 500 acres, and they will have a large output for many years.

The formation of what is to be known as "The Scottish Miners' Anti-Royalty and Labour League" has caused a good deal of talk in mining circles, not so much because of the importance to be attached to the League, as on account of the fact that one of its promoters succeeded in obtaining letters from Lord Aberdare, Mr. Bright, and other eminent men on the subject. Lord Aberdare declined to give an opinion on the proposal to abolish royalties, because he derives much of his income from a mineral property; but Mr. Bright wrote—"If you mean that you can honestly propose to seize on the minerals beneath the surface of the earth, and to abolish all the rights of the present owners, I cannot give any support to a league formed for such a purpose." The object of the League is precisely what Mr. Bright states; but no one whose opinion is worth having considers that there is the least chance of success attending its efforts, or that, if successful, any material advantage to the miners could possibly follow.

The shipbuilding yard of Messrs. Aitken and Mansell, Glasgow, has been closed, and all the workmen dismissed, because the last available contract is finished. Work will, however, be resumed on a new order being recovered. The trade generally is very dull at present, although by excellent management the London and Glasgow Engineering and Iron Shipbuilding Company has been able to earn a dividend of 5 per cent.

WALES & ADJOINING COUNTIES.

(*From our own Correspondent.*)

A SURVEY of the condition of the steel trade from Ebbw Vale to Dowlais shows that if a turn should take place in the steel trade, Wales will be in an admirable condition to meet it. The best of scientific appliances, the least expenditure for horse and manual labour meet one everywhere, with, I regret to say, only a modicum of activity. Two or three turns a week appear to be the average, and the conviction is forced upon the mind that considering the longer life of a steel rail compared with an iron one, and the decrease in demand, there are more works in existence than are needed for the amount of business to be done. The salvation of several of the works here, so far, is due to the prosperity of the coal trade, and the fact that works in question have a good area of coalfield. Should the coal trade decline disaster must follow. Less than 2000 tons of manufactured iron and steel left the Welsh ports last week. The principal ones from Newport were for Rio Grande and Christianstad. The iron ore trade continues dull, and I note that at several of the large works there has been a perceptible falling off in fresh importations, and stocks that have been kept in hand are now being attacked.

In tin-plate there is not much change to note. Makers are tolerably busy, but stocks are accumulating more than they did, and the result is that market prices keep down and there is not so much animation in the trade, buyers holding back.

I am glad to see that Gadlys tin-plate works, which have been so long closed, are coming again to the front, and under the management of their old proprietor, Mr. Hosgood, formerly manager of Plymouth Works.

There seems more activity in tin-plate works' speculations of late. A company is forming at Lydbrook with a capital of £50,000, to work the Richard Thomas and Son warrant tin-plate works. 1200 tons tin-plate were shipped by the Cambrian Company, Swansea, last week to New York. Hopes are strong concerning the Risca and Cardiff Railway. It was a pity that it was ever abandoned, but this was done, I have understood, to try and avoid the opposition of powerful landed proprietors. The Rhymney and Great Western branch from Makers' Yard into Merthyr is making satisfactory progress. The centres of the great viaduct are models of good work. This will be the finest in South Wales with the solitary exception of the Cefn Viaduct on the Brecon Railway.

Colliery enterprise is promising. Sinking operations have been started in the Merthyr Valley by Ebenezer Lewis and Company. This will be one of the most important colliery undertakings in Wales. Messrs. Beith are busily engaged with the new colliery of D. Davies and Company, and are doing good work. In addition I hear of the Corrwg Rhondda Company to work the Glyncorrwg Colliery Company's area. Mr. Perch, of Cardiff, and others are in the undertaking. In the Forest of Dean the Lydney and Crump Meadow Collieries Company has been floated. Capitalists are represented by Chepstow and Newport, as well as by local men.

The Powell Duffryn Company is beginning to use the new line from the Rhondda to Newport, the Pontypridd, Caerphilly, and Newport Railway, and the quantities sent down from Wednesday last have imparted a fair degree of activity to the port. When this line and the Swansea are fully occupied, the wonder will be what the new line and docks at Barry will do.

In all the argument that has taken place in this great fight, one point seems overlooked. It is admitted that two months ago the collieries were turning out their fullest quantities. Every colliery teemed with men and every man did his uttermost. It is also admitted that the area of untaken virgin coal ground is very small. Where, then, will come the coal for the two new lines and that of the Barry and docks except by abstracting from the Taff? And who will take the coal from the Taff and Bute Docks and pay the higher dues that mus be demanded? Clearly only the promoters, who will consent to an imposition of extra dues in the hope that Barry profits will reimburse.

The coal trade is quieter, and many steamers left the port last week in ballast. At the docks, Cardiff, one set of men represent trade as buoyant, others slack. The first are the chief coalowners who are well supplied with contracts. The others are open to the general trade. Possibly naval operations may give a spurt to coaling ports in another week.

Anthracite trade at Swansea is dull. General trade tolerably brisk. At Newport last week shipping was interfered with considerably by the breaking of an accumulator at the old dock.

Small steam easy; pit wood is getting a drug again. Patent fuel works are well employed. In the matter of Rhondda coals No. 2 is in freer demand than No. 3.

NAVAL ENGINEER APPOINTMENT.—The following appointment has been made at the Admiralty:—Richard T. Rundle, chief engineer, to the Lily.

INDIAN RAILWAYS.—The extension of the Madras Railway from the present terminus at Beypore to Calicut has been sanctioned at an estimated cost of 1,300,000 rupees.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

**** It has come to our notice that some applicants of the Patent-office Sales Department, for Patent Specifications, have caused much unnecessary trouble and annoyance, both to themselves and to the Patent-office Officials, by giving the number of the page of* THE ENGINEER *at which the Specification they require is referred to, instead of giving the proper number of the Specification. The mistake has been made by looking at* THE ENGINEER *Index, and giving the numbers there found, which only refer to the pages, in place of turning to those pages and finding the numbers of the Specification.*

Applications for Letters Patent.

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

16th September, 1884.

12,437. SEWING MACHINES, W. Jones, London.
12,438. WOOD PAVING, &c., R. H. Fraser and J. Halley, Glasgow.
12,439. TENNIS RACQUETS, F. W. Stoddart, Bristol.
12,440. FOLDING HEADS of CARRIAGES, J. G. Harrison, Birmingham.
12,441. SIGNALS for RAILWAYS, W. P. Thompson.—(*G. A. Reynolds, U.S.*)
12,442. DAMPING LITHOGRAPHIC STONES, F. Horsell, Leeds.
12,443. SELF-ADJUSTING PLATE ROLLERS, &c., R. Meffert, Liverpool.
12,444. STANDARD for SHEEP NETTING, &c., C. V. Jackson, Northampton.
12,445. EFFECTING COMMUNICATION in TELEPHONIC SYSTEMS, L. J. Crossley, J. F. Harrison, and W. Emmott, London.
12,446. BREAD-FORMING MACHINES, J. S. D. Shanks and D. B. Brown, Belfast.
12,447. COUPLING for PIPES, &c., H. J. Allison.—(*A. Dorgans, Tarbes.*)
12,448. CONDENSERS FOR MARINE ENGINES, S. S. Bromhead.—(*J. Henderson, New South Wales.*)
12,449. BEARING for BICYCLES, &c., A. C. Henderson and F. N. Cookson, London.
12,450. TRICYCLE, A. C. Henderson and F. N. Cookson, London.
12,451. MACHINERY for the MANUFACTURE of FISHING NETS, A. J. Allan, Glasgow.
12,452. TOBACCO PIPES, F. S. Rothschild.—(*C. Cayron, Saint Claude.*)
12,453. INTERNALLY STOPPERED BOTTLES, D. Rylands, near Barnsley.
12,454. PROPELLING and STEERING BALLOONS, G. Tofts, London.
12,455. MACHINERY for ENGRAVING, G. McK. Guerrant, London.
12,456. HYDROCARBON GAS, W. H. Beck.—(*W. FitzC. M. McCarty, St. Petersburg.*)
12,457. TREATMENT of PETROLEUM, L. A. Groth.—(*T. N. Flesch, Annweiler.*)
12,458. SAFETY BRAKE for ELEVATORS or LIFTS, L. A. Groth.—(*F. Schnizlein, Munich.*)
12,459. CLEANSING TIN and TERNE PLATES, J. Jenkins, London.
12,460. INFANTS' FEEDING BOTTLE, C. W. Chapman, London.
12,461. DOUBLE-CUTTING SINGLE-SHEAR MOWING MACHINE, W. Shears, London.
12,462. FORMING JOINTS in TANKS, &c., F. J. Biggs and T. Ludlow, London.
12,463. BREECH-LOADING FIRE-ARMS, L. Armanni, London.
12,464. FOLDING CAMP-BED, &c., H. J. Haddan.—(*A. Luger, Vienna.*)
12,465. PROPELLING SHIPS, F. Hime, London.
12,466. SAWING MACHINERY, F. W. Hofmann, London.
12,467. RAILWAYS, T. P. Chandler, jun., London.
12,468. TYPE WRITERS, A. J. Boult.—(*L. S. Burridge and N. R. Marshman, U.S.*)
12,469. SUGAR, A. Fesca, London.
12,470. NAILS, G. E. Smart, London.
12,471. DISTRIBUTING GAS and AIR in FURNACES, J. P. Roe, London.
12,472. DYEING FABRICS ANILINE BLACK, &c., C. R. Preibisch, London.
12,473. GEAR MOULDING MACHINES, P. L. Simpson, Minneapolis, U.S.
12,474. PUMPING APPARATUS, W. Hogg, London.
12,475. PRESSES for PRINTING in COLOURS, D. E. Mack, London.
12,476. TONGS for GAS and WATER TUBES, &c., A. Land, London.
12,477. ROTARY ENGINES ACTUATED by WATER, &c., J. Hocker, London.
12,478. ROLLER BLIND, J. E. Hopkinson, London.
12,479. TRANSMITTING POWER, J. A. Ewing, London.
12,480. DECORATING ARTICLES of EARTHENWARE, W. Forester, London.
12,481. GAS, A. M. Clark.—(*A. and T. Henning, U.S.*)
12,482. VIGNETTING APPARATUS for PHOTOGRAPHIC PRINTING FRAMES, E. D. Adcock, London.
12,483. SEPARATING SALTS from SOLUTIONS CONTAINING the SAME, O. Braun, London.
12,484. CONFECTIONERY LOZENGES, W. R. Lake.—(*O. R. Chase, United States.*)
12,485. DECORATING, &c., on GLASS, &c., B. E. Foster, London.

September 17th, 1884.

12,486. HOLLOW BRICKS, &c., T. Freeman, jun., and C. Eardley, Hanley.
12,487. HEAD RAIL for TRAMWAYS, &c., J. Guest and H. J. Brookes, Smethwick.
12,488. BOILERS for HOT-WATER HEATING, J. Jackson, Newcastle.
12,489. STRETCHING, &c., WOVEN WIRE MATTRESSES, &c., J. Westgarth, Warrington.
12,490. DYEING, H. Grandage and R. E. Steel, Bradford.
12,491. SAFETY HOLDER, &c., for VEHICLES, J. E. Eldridge, South Molton.
12,492. SELF-INDICATING TARGET, J. H. Jack, Edinburgh.
12,493. STEAM WASHERS, C. H. Guest, Birmingham.
12,494. HEATING, &c., A. Gerken, London.
12,495. WEIGHING, &c., MACHINES, W. Oakley, London.
12,496. WITHDRAWING CONTENTS of INTERNALLY STOPPERED BOTTLES, W. Stott, London.
12,497. GAS FURNACES for STEAM BOILERS, &c., J. W. Macfarlane and J. J. Coleman, Glasgow.
12,498. DIVIDING, &c., CRUDE PETROLEUM, J. C. Mewburn.—(*Halvorson Process Company, United States.*)
12,499. COVERING ROOFS with TILES, G. H. Couch, London.
12,500. INDICATING LOADS on RAILWAY TRUCKS, &c., J. Y. Johnson.—(*F. W. Minck, Tiplitz.*)
12,501. BORING TOOL, W. Morling, London.
12,502. SEAT FITTINGS for VEHICLES, G. Morris, Norwich.
12,503. INCREASING the HOLD upon WATER in SWIMMING, &c., G. E. Smart, London.
12,504. ANCHORS, G. E. Smart, London.
12,505. TAKING TWO-THIRDS of the FRICTION off the SHUTTLE when it ENTERS and LEAVES the SHUTTLE-BOX, R. Fitton, Oldham.
12,506. PROPELLING, &c., VESSELS, A. W. L. Reddie.—(*A. P. Blanchet, Monteriouz.*)
12,507. BICYCLES, &c., T. Warwick, London.
12,508. VIOLINS, &c., R. Meeson, London.
12,509. HOLDERS for NIGHT LIGHTS, &c., E. Camp, London.
12,510. INSTRUMENT for DEPRESSING the TONGUE for SURGICAL PURPOSES, J. W. Cousins, Southsea.
12,511. BOTTLE STOPPERS, J. J. Varley, Merton.
12,512. FILLING BOTTLES with AERATED LIQUIDS, J. J. Varley, Merton.
12,513. CART SADDLE BRIDGES, J. Gray, London.
12,514. ELECTRIC ALARM APPARATUS, H. A. Mavor, London.
12,515. OPENING and CLOSING WINDOWS, C. J. Heaton, London.
12,516. GALVANIC BATTERIES, P. R. de F. d'Humy, London.
12,517. GALVANIC BATTERIES, P. R. de F. d'Humy, London.
12,518. GLASS JEWELLERY, &c., P. R. de F. d'Humy, London.
12,519. AUTOMATICALLY DISCHARGING FLUID into FLUSHING TANKS, &c., D. J. and C. B. Callow, and H. J. Eck, Walham Green.
12,520. FILTERING APPARATUS, J. Kroog, London.
12,521. SYPHONS, W. Clark.—(*E. Fitch, U.S.*)
12,522. MARINE DRAGS, J. Linkleter and W. P. Mears, Tynemouth.

18th September, 1884.

12,523. STOPPING HOLES BORED for BLASTING, J. Clark, London.
12,524. ELECTRIC GATE-BLOCKING APPARATUS, E. E. Evans, Brimscombe Mills, near Stroud.
12,525. CARTRIDGE CASES for FIRE-ARMS, C. H. Maleham, London.
12,526. WATER-GAUGE COCKS, D. Pailthorp and W. Maiden, London.
12,527. KEYLESS WATCHES, G. Hurdle, Southampton.
12,528. PREPARING, &c., the STRANDS of SILK, W. Trafford, Leek.
12,529. OIL and GAS LAMPS, C. H. Ancill, Birmingham.
12,530. SELF-ADJUSTING RAILWAYS, R. Lister and S. Hodgson, Coatham.
12,531. AERIAL NAVIGATION, J. Glover, jun., Birkdale.
12,532. HYDRAULIC CRANES, &c., H. Smith, Glasgow.
12,533. PEGGING and FINISHING VELVET, A. Ridge, Manchester.
12,534. STOPPERING BOTTLES, &c., J. Blocksidge, Birmingham.
12,535. IRONING, &c., TEXTILE FABRICS, W. Brierley.—(*F. A. Zschiesche, Cottbus.*)
12,536. WITHDRAWING LIQUIDS from CASKS, &c., J. Steen, Wolverhampton.
12,537. WEAVING PILE FABRICS, F. Loll, London.
12,538. WATER-CLOSETS, W. Mangnall, London.
12,539. RENDERING the SEATS of VELOCIPEDES ADJUSTABLE, H. J. Hudson, London.
12,540. CLEANING GRAIN, W. H. Spence.—(*L. J. Charpentier, France.*)
12,541. CONDENSERS and REFRIGERATORS, S. Puplett, Knowle.
12,542. ARTIFICIAL PRODUCTION of ICE, S. Puplett, Knowle.
12,543. COMPRESSING the CONDENSABLE GASES, S. Puplett, Knowle.
12,544. ICE MOULDS, S. Puplett, Knowle.
12,545. HEALING OINTMENT, M. King, London.
12,546. INKSTANDS, A. H. Reed.—(*M. Küster, Berlin.*)
12,547. ELECTRIC BELLS.—(*E. Recordon et Compagnie, Geneva.*)
12,548. APPARATUS for CONTAINING DISINFECTING MATERIAL, F. J. Austin, London.
12,549. BUTTONS, R. Elsdon, London.
12,550. TOP PIECING the HEELS of BOOTS and SHOES, T. Peperdy, H. J. Cherry, and W. Earp, London.
12,551. CIGAR LIGHTS or FUSEES, G. A. Sweetser, London.
12,552. RAILWAY CARRIAGE FRAMES, F. H. Rosher and F. E. Rosher, London.
12,553. ELECTRIC BELTS and CORSETS, B. Wecksler, London.
12,554. SCISSORS or SHEARS, J. C. Eddison and J. E. Wadsworth, London.
12,555. BOTTLING BEER, WINE, SPIRITS, &c., S. Bunting, Dublin.
12,556. CONVERTERS for IRON and STEEL MANUFACTURE, J. Heaton, London.
12,557. CHILD'S SAFETY COT, CRIB, &c., W. A. Rees, London.
12,558. VALVE GEAR for STEAM ENGINES, T. Hunt, London.
12,559. LOADING and DISCHARGING VESSELS, R. Stone, London.
12,560. MILLS for CRUSHING, &c., SUBSTANCES, W. H. Thompson, London.
12,561. RAISING SUNKEN SHIPS or VESSELS, W. S. Vaughan, London.
12,562. MAKING EMULSIONS, C. G. F. de Laval, London.
12,563. SAUCEPANS, T. J. Constantine, London.
12,564. TREATMENT of IVORY or BONE, M. Low, London.
12,565. PRESERVING FRUITS, A.W. M. Leicester, London.
12,566. SIZING of PAPER, A. Mitscherlich, London.
12,567. COMBINATION TAG and ENVELOPE, A. J. Boult.—(*E. W. Dennison, U.S.*)
12,568. TRAVELLING GEAR, G. J. Smith, London.
12,569. BLADES of CRICKET BATS, W. P. Venables, Windsor

September 19th, 1884.

12,570. SCOURING, &c., WHEAT, &c., J. Craig, Liverpool.
12,571. CIGAR HOLDERS, &c., J. Cheshire, Birmingham.
12,572. TEA-POTS, &c., J. F. Fuller, Dublin.
12,573. PREVENTING NUTS from getting LOOSE, S. W. Smith, Coventry.
12,574. MOUNTING, &c., CORNERS, &c., of FRENCH BEDSTEADS, T. Kendrick, Birmingham.
12,575. SASH FASTENERS, J. S. W. Edmunds, Birmingham.
12,576. BLIND RACK PULLEY, T. Thacker and S. J. J. Rooke, Birmingham.
12,577. WIRE FIRE GUARDS, &c., H. Hall, London.
12,578. WINDOW SASH FASTENERS, J. Ashworth, Chester.
12,579. STEAM CULTIVATORS, J. Ralph and J. S. Talbot, Shaftesbury.
12,580. HOLDING GUNS, &c., W. P. Jones, Birmingham.
12,581. PERMANENT WAY of RAILWAYS, W. H. Smith, Birmingham.
12,582. ACID BITING for EMBOSSING, &c., T. Guyot, Edinburgh.
12,583. SCREW-CUTTING LATHES, W. P. Thompson.—(*Nathan Blum, Paris.*)
12,584. WORM CONVEYORS for MILLING MACHINERY, &c., P. W. Pearson, Liverpool.
12,585. SAMPLING, &c., APPARATUS for SPIRITUOUS LIQUORS, &c., J. O'N. Mackie, Liverpool.
12,586. BREECH-LOADING SMALL-ARMS, C. G. Bonehill and A. J. Simpson, Birmingham.
12,587. VELOCIPEDES, W. Morgan, Birmingham.
12,588. TRAVELLING CAP, M. Hesse.—(*Max Adam, Posen.*)
12,589. PLANING, &c., MACHINES for WOOD-WORKING, E. and G. H. Warburton, Manchester.
12,590. INDICATORS for RAILWAY MILK CANS, &c., E. R. Baller, Birchfield.
12,591. VERTICAL STEAM BOILERS, R. Coles, London.
12,592. LOBSTER, &c., TRAP, W. C. W. Panter, Boscastle.
12,593. CONCENTRATION of ORES, &c., T. J. Barnard, London.
12,594. SUN DIAL, H. Curzon, London.
12,595. TREATMENT of SLAG, H. J. Haddan.—(*G. Deumelandt, Potsdam.*)
12,596. REGULATING the COMBUSTION of FUEL in STEAM BOILERS, &c., T. Kennington, E. P. Garth, and C. H. Barker, Sheffield.
12,597. BEER ENGINES, F. N. and H. T. Warne, London.
12,598. PERCENTAGE CALCULATORS, W. S. Moore, London.
12,599. SHOVEL, A. Browne, London.
12,600. GUILLOTINE EGG-CUP, G. Asher, Birmingham.
12,601. CASH TILL for DELIVERING COIN, J. M. Eglin, London.
12,602. PIPE COUPLINGS, J. Bennie, London.
12,603. ENGINES WORKED by GAS, &c., W. and J. H. Hill, London.
12,604. TANDEM VELOCIPEDE, H. J. Hudson, London.
12,605. ANNEALING FURNACES, J. Jones, London.
12,606. SHEEP-SHEARS, C. Burgon, London.
12,607. VENTILATING APPARATUS, W. L. Wise.—(*C. E. L. Cross, Vienna.*)
12,608. SPEED INDICATORS, H. W. Schlotfeldt, London.
12,609. PIANOS, J. Y. Johnson.—(*L. Luscuyer, Mulhouse.*)
12,610. VELOCIPEDES, &c., J. Aytoun, Glasgow.
12,611. VENTILATING FANS, G. Greig, London.
12,612. CENTRIFUGAL GOVERNOR for ENGINES, R. H. Heenan and R. H. Froude, London.
12,613. ARMOUR-PLATES, T. E. Vickers and E. Reynolds, London.
12,614. NOSINGS for STAIR TREADS, F. W. Hembry, London.
12,615. CISTERNS for FLUSHING CLOSETS, A. Sweet, London.
12,616. RAILWAY MILK CANS or CHURNS, J. Loving, London.
12,617. SURFACE CONDENSERS and HEATERS, J. Kirkaldy, London.
12,618. SUPPLYING HEATED FEED-WATER to BOILERS, J. Kirkaldy, London.
12,619. MANTEL and CHIMNEY PIECES, J. E. Sams, London.

20th September, 1884.

12,620. CLEANING BOOTS, &c., H. Churchman, London.
12,621. ATTACHING SHIPS' BOATS, J. Linkleter, Tynemouth.
12,622. FASTENING NECKTIES, &c., J. Smith, Stoke-upon-Trent.
12,623. COUPLING for ELECTRIC WIRES, R. W. Vining, Liverpool.
12,624. INDICATING NAMES of STATIONS, J. Pease, Halifax.
12,625. LEVER LOCKS, W. H. Chubb, Birmingham.
12,626. ELECTRIC ARC LAMPS, A. Pfannkuche, Dorking.
12,627. CONVEYING GRAIN HORIZONTALLY, H. J. Worssam, London.
12,628. METAL PROTECTORS for BOOTS and SHOES, S. and G. Fox, Birmingham.
12,629. DYNAMO-ELECTRIC MACHINES, A. E. Wadley, London.
12,630. ROLLER BEAM and FLY BOARD CLEANER, J. Pickup and E. Pickup, Manchester.
12,631. RAMPS, J. Morris, jun., Salford.
12,632. VELOCIPEDE PEDALS, J. Carpenter, Southampton.
12,633. SCREWS, J. Shaw, Bradford.
12,634. HOLDING SYPHONS while CLEANING, H. J. Melsom, London.
12,635. APRONS, J. Edelston, Manchester.
12,636. ACTUATING the LATHE, &c., of LOOMS, L. Lacerson.—(*H. Wilke, Moscow.*)
12,637. OPERATING VALVES, J. Beveridge, London.
12,638. TRANSPORTING, &c., FOOD, J. C. Mewburn.—(*A. R. Roosen, Hamburg.*)
12,639. SUPPORTING STAND PIPES, W. Richardson, Mansfield.
12,640. PRODUCTION of MOTIVE-POWER, C. Tellier, London.
12,641. WATERPROOF SOLES for BOOTS and SHOES, J. L. Hodgkins, London.
12,642. COSTUME and MANTLE STANDS, J. Goodwin, London.
12,643. PURIFICATION of SEWAGE, W. Donaldson, I. Shone, and E. Ault, London.
12,644. SPRINGS for DOORS, R. Adams, London.
12,645. SECURING HANDLES to TABLE KNIVES, &c., C. Wingfield, London.
12,646. UNIQUE HAT REVIVER, W. Luksch, London.
12,647. AERIAL LOCO-MOTORS, G. W. Simmons, London.
12,648. SURFACE CONDENSER for ENGINES, C.W. Wardle, London.
12,649. BUCKLES, T. Walker, London.
12,650. MOUNTING ARTIFICIAL TEETH, B. J. B. Mills.—(*J. C. Pompéien-Piraud, Lyons.*)
12,651. TELEPHONE APPARATUS, C. A. Gisborne.—(*F. N. Gisborne and D. H. Keeley, Canada.*)
12,652. COOKING UTENSILS, C. S. Snell, London.
12,653. ANTI-FOULING PAINTS, F. M. Lyte, London.
12,654. ELECTRIC GOVERNORS, J. Swinburne, Brockley
12,655. RECEIVING and GIVING CHANGE for MONEY and DETECTING BASE COIN, G. E. Absell, London.
12,656. COMPOUND ENGINE, W. Robertson and G. A. Goodwin, London.
12,657. VERTICAL ENGINE, W. Robertson and G. A. Goodwin, London.
12,658. HORIZONTAL ENGINE, W. Robertson and G. A. Goodwin, London.
12,659. METALLIC BEDSTEADS, &c., F. Hoskins, Birmingham.
12,660. CONDENSING CARDING ENGINES, J. Haigh and A. Stephenson, Manchester.
12,661. PIPES for SMOKING TOBACCO, J. J. Croxton, Liverpool.
12,662. PITCH CHAINS, J. Hay, Glasgow.
12,663. SECURING RAILWAY RAILS in their CHAIRS, S. W. Smith, near Coventry.
12,664. AFFIXING POSTAGE STAMPS upon LETTERS, &c., E. A. Simmons, Manchester.
12,665. STEAM ENGINES, J. Dodd, H. Kay, and J. Revell, London.
12,666. WRAPPING UP SOLUBLE or INSOLUBLE BLUE, W. Edge, London.
12,667. PORTABLE OVEN, W. Hill, London.
12,668. PROPELLING BALLOONS, G. Tofts, London.
12,669. CONVERTING RECIPROCATING into ROTARY MOTION, F. M. Wright, London.
12,670. PLOUGHS, J. Barlow, London.
12,671. WEAVING PILED CARPETS, A. J. Boult.—(*Kohn and Warslavik, Austria.*)
12,672. BREECH-LOADING FIRE-ARMS, L. Armanni, London.
12,673. BREECH-LOADING FIRE-ARMS, L. Armanni, London.
12,674. WATERPROOF PAPER, J. D. Carter, London.
12,675. CARBONS for ELECTRIC LAMPS, M. Evans and F. Wynne, London.
12,676. STEAM STEERING APPARATUS, T. P. Hollick and E. Wimshurst, London.
12,677. GAS GOVERNORS, H. Besson and J. H. Burrows, London.
12,678. POWER LOOMS for WEAVING VELVETS, &c., W. E. Gedge.—(*C. Chavant, Lyons.*)
12,679. UMBRELLAS, &c., for CARRIAGES, C. H. Butlin, London.
12,680. TUBE SCRAPER, W. H. Gales, London.
12,681. TREATMENT of OILS and TARS, T. Durrans, London.
12,682. CLOSETS, E. W. Lyne, London.

ABSTRACTS OF SPECIFICATIONS.

Prepared by ourselves expressly for THE ENGINEER *at the office of Her Majesty's Commissioners of Patents.*

1865. COMPOUNDS IN THE NATURE OF VULCANISED INDIA-RUBBER AND HARD-RUBBER, *A. H. Huth, London.*—12*th April*, 1883.—(*Not proceeded with.*) 2d.

This relates to a mixture of india-rubber, sulphur, camphor, kauri, farina of mustard, or linseed from which the oil has been separated, lime, glycerine, and insulite, in specified proportions.

2876. MANUFACTURE OF BELTING, *J. K. Tullis, Glasgow.*—9*th June*, 1883. 6d.

This consists in protecting the sides or edges of canvas, cotton, and woven belting generally, or felted belting, by securing a strip of leather to each edge preferably by means of metallic wire.

5170. APPARATUS FOR DETACHING COAL AND STONE, *T. W. Asquith, R. B. Ormsby, and T. Nicholson, Northumberland.*—31*st October*, 1883. 6d.

This relates to an expansible plug to be inserted in holes bored in the coal or stone, which is then broken down by causing the plug to expand by suitable mechanical means.

5355. PROCESS FOR THE TREATMENT OF SULPHUROUS AND ARSENICAL COMPOSITE ORES CONTAINING NICKEL, COBALT, AND OTHER METALS, *B. J. B. Mills, London.*—13*th November*, 1883.—(*A communication from P. Manhès, France.*) 4d.

Sulphurous and arsenical ores of nickel, cobalt, and copper are fused in order to separate them from their gangue, and then refined by a converter until the iron has almost entirely disappeared, after which they are treated whilst still sulphurous, or arsenico-sulphurous, pulverisable and attachable by acids, either by the wet method or dry electrolysis, if desired to separate the various elements, or in the case of ferrous meltings, slightly sulphurous by fusion in a basic cupola or other furnace with excess of bases, and of carbon if desired only to obtain a desulphurised alloy of the metals contained.

5652. ROLLER MILLS FOR GRINDING, *W. P. Thompson, Liverpool.—5th December*, 1883.—(*A communication from D. E. Dowling, New York.*) 6d.

The object is to provide means whereby middlings and similar grain products may be delivered between grinding rolls in a constant and uniform manner, and it consists in the use of a feed hopper extending from end to end above a pair of grinding rolls, a feed roll located beneath the mouth of the hopper, and an agitator within the hopper provided with teeth or fingers arranged to reciprocate immediately above the feed roll.

5690. TOGGLE PRESSES, *H. H. Lake, London.—10th December*, 1883.—(*A communication from E. B. Meatyard, Wisconsin, U.S.*) 6d.

This relates to presses chiefly designed for pressing metal ingots, and it consists of a frame which, when two presses are used, carries one at each end. Between the two presses an upright frame is arranged, and between the uprights of which upper and lower blocks are arranged, and have flanges acting as guides. The actuating toggle arms are pivotted at their outer ends to these blocks, and their inner ends are bifurcated and connected to knuckle joints arranged on a right and left-handed screw carrying a central worm wheel gearing with a worm on a shaft mounted at its outer end in a movable journal, and connected by a link rod to the worm shaft. A pulley on the worm shaft drives the screw in either direction. Each press has a press toggle composed of a block and upper and lower arms, pivotted respectively to the head-piece of the press, and the followers, the arms being arranged in pairs above and below the block. The blocks are connected by guide toggle arms to the guide blocks, to which the actuating toggles are connected.

5693. STEAM HAMMERS, &c., *H. H. Lake, London.—10th December*, 1883.—(*A communication from E. B. Meatyard, Wisconsin, U.S.*) 8d.

Two independent rams are arranged to reciprocate in the same vertical plane, and are combined with a single steam cylinder and two pistons working therein and connected respectively to one of the rams, which are thereby moved to and from each other by the direct action of the pistons. The pistons are in two sections, and are attached to their stem in a special manner. A rotary valve of special construction is employed for the distribution of the steam.

5797. PRODUCING MOTIVE POWER, *M. P. W. Boulton, Italy, and E. Perrett, London.* — *18th December*, 1883. 8d.

The inventor claims, First, in a heater for heating gas by its passage through the interstices of heated refractory material, providing an annular passage for the cool fluid between the outer shell and internal heated material; Secondly, the use of a cooler containing suitable material wetted by water for the purpose of cooling the working fluid of hot air engines; Thirdly, in an engine worked by highly heated fluid, the combination of a heater and cooler, and their connecting parts with the cylinders of the engine; Fourthly, in engines worked by steam, the combination of a boiler with a heater containing refractory material disposed with numerous interstices, the whole arranged and operating in such manner that the heater at one time is heated by fire under ordinary pressure, and afterwards is put into communication with the boiler and engine, so that the steam on its way from the boiler to the engine passes through the interstices of the heater, and becoming thereby superheated, enters the cylinder in this state.

5888. ROTARY ENGINES AND ROTARY BLOWERS AND PUMPS, *W. Paddock, Birmingham.—28th December*, 1883. 10d.

Within a cylindrical case is a hollow drum mounted on the main shaft of the engine, and within which are two other drums of progressively diminishing diameter attached to the first-mentioned drum. In the annular spaces between these drums other drums are situated concentrically to each other and excentrically to the first drums, this second series being always in contact at one line with the first series. The first drum carries a flap or plate forming a piston which passes through a slot in the outer drum of the second series. Steam admitted to the case acts upon the piston and causes it to rotate, carrying round the main shaft.

5889. HYDRAULIC LIFTS, FLOATING DOCKS, PONTOONS, &c., *J. Standfield, Westminster.* — *28th December*, 1883. 10d.

This relates to the connection with a floating dock of a rigid arm projecting from its side to a fulcrum upon the shore or upon another floating structure, and by means of which the dock or pontoon is prevented from listing either to port or starboard. The fulcrum can be raised or lowered so as to control the rise and fall of the dock. A dock with folding sides is described, and such sides may be capable of being raised and lowered.

5933. SECURING OR SHORING UP DANGEROUS STRUCTURES, &c., *W. E. Heath, London.—29th December*, 1883. 6d.

A tie rod, rope, or chain is arranged between the apex of the shore and the base of the building, and in it a swivel screw is provided, by means of which tension can be put upon the tie so as to draw the two points together and exercise a pressure on the surface of the wall or structure to be supported. The tie for convenience may be made in lengths.

5945. GOVERNORS FOR REGULATING THE ELECTROMOTIVE FORCE OF ELECTRIC CURRENTS AND THE SPEED OF MOTORS, *W. Hartnell, Leeds, P. W. Willans and R. E. B. Crompton, London.—31st December*, 1883. 10d.

This relates to means for regulating the electromotive force of electric currents either by automatically varying the speed of the prime mover which drives the dynamo-electric generator; by automatically varying the speed of the generator itself; or by automatically introducing such changes into the electro-magnetic arrangements of the generator as will vary its output in current, or electro-motive force, without varying its speed. Reference is made to specifications Nos. 1184 and 5291, of 1883.

5947. PREPARATION OF PHOTOGRAPHS AND TREATMENT OF DRAWINGS, &c., TO IMITATE STAINED GROUND, CUT, OR EMBOSSED GLASS, *G. Rydill, London.—31st December*, 1883. 1s. 2d.

This consists in treating the prints with pine or other oil or varnish in a vessel under hydraulic, vacuum, or air pressure, and then placing them between sheets of glass, the edges of which are cemented together.

5962. MANUFACTURE OF WHITE LEAD, *H. J. Haddan, London.—31st December*, 1883.—(*A communication from F. Schmoll, Germany.*) 6d.

Lead is formed into thin plates or thin shavings, and placed on laths side by side and superposed in oxidising chambers, which are closed when full and the vapour from vinegar admitted. Carbonic acid is also admitted.

5987. INCANDESCENT ELECTRIC LAMPS, &c., *L. Goldberg and A. L. Fyfe, London.—31st December*, 1883. 8d.

The filaments, made from thread and carbonised in the usual manner, are formed into curves so complex that their outlines are rendered indistinguishable, and merge, as it were, into each other. The invention further relates to holders and a switch for incandescent lamps.

5988. DOMESTIC TURKISH OR HOT-AIR BATHS, &c., *M. Dray and J. Bernard, London.—31st December*, 1883. 4d.

The bath is arranged so that it can be made to stand in an upright position when not in use, the bath being mounted on trunnions in a suitable casing, at top of which is a shower bath. A skeleton frame covered with fabric is hinged so that it can be closed over the bather when desired to take a Turkish or hot-air bath. A mechanical shampooer, consisting of a rotary brush mounted on a perforated spindle for the supply of water, is also described.

SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

303,075. COUPLING, *William P. Towne, New York, N.Y.—Filed February 25th*, 1884.

Claim.—(1) The combination, with a nozzle or pipe provided with a laterally-extending flange and a pipe also provided with a laterally-extending flange, of a yoke partially surrounding one pipe, adapted to be slipped on and off the same in a direction transverse to the axis thereof, and fitting, when in place, against its flange, arms extending from the yoke to the other pipe, and adjustable devices for acting against the flange of the pipe last named so as to draw the two parts together, substantially as specified. (2) The

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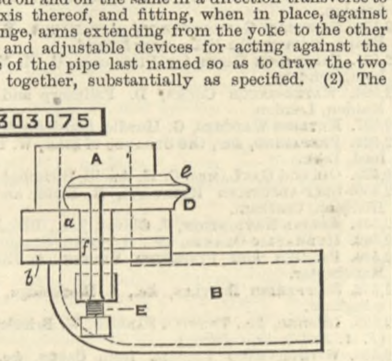

combination of the nozzle A, provided with the flange *a*, the pipe B, provided with the flange *b*, the coupling D, consisting of the yoke *e*, partially surrounding the part A, and adapted to be slipped on and off the same in a direction transverse to the axis thereof, and arms *f*, provided with screws E, substantially as specified.

303,083. STEAM ENGINE, *H. Herman Westinghouse, Pittsburg, Pa.—Filed February 16th*, 1884.

Claim.—(1) The combination, substantially as set forth, of a pair of vertical single-acting cylinders, each located above and having its piston connected to the crank pin of a double crank upon a common crank shaft, a main or distribution valve working in a valve chamber between said cylinders and governing the supply and exhaust thereof, and a centrifugal governor fixed upon the crank shaft between its cranks, and coupled directly to an excentric which reciprocates the main valve and is movable transversely relatively to the crank line. (2) The combination, substantially as set forth, of a pair of vertical single-acting cylinders, each located above and having its piston connected to the crank pin of a double crank upon a common crank shaft, a differential piston main or distribution valve, operated by an excentric on said shaft and governing the supply and exhaust of the cylinders, said valve having an upper piston of greater area than its lower piston, and a valve chamber having a supply pipe which admits steam between said pistons, these members being combined for joint operation to effect the balancing of the weight of the valve and excentric by the excess of pressure on the larger valve piston. (3) The combination, substantially as set forth, of a pair of vertical single-acting cylinders, each having a port for the admission and exhaust of steam at or near its upper end, pistons fitting said cylinders and connected to

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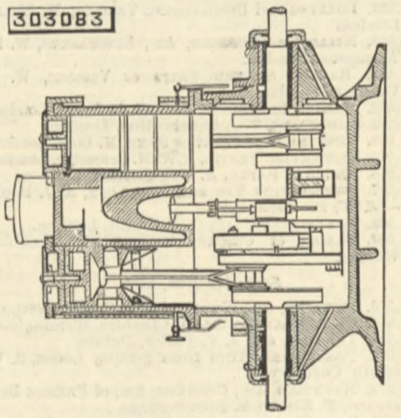

cranks on a common crank shaft, and a water relief passage leading from each of said cylinders to the exhaust pipe, said passages having their openings to the bore of the cylinders located at such level therein as to be uncovered by the pistons when at the lowest extremity of their strokes. (4) The combination, substantially as set forth, of a pair of vertical single-acting cylinders located above a closed crank case, and having their pistons coupled to cranks on a shaft rotating therein, a main or distribution valve governing the supply and exhaust of said cylinders, and a drain pipe leading from the exhaust passage to the main valve chamber, to the crank case, and provided with a regulating cock or valve. (5) The combination, substantially as set forth, of a pair of vertical single-acting cylinders located above a closed crank case, and having their pistons coupled to cranks on a shaft therein, a main valve working in a valve chamber located between said cylinders and actuated by an excentric on said shaft, an oil reservoir fitting in the space between the cylinders and valve chamber, and oil supply pipes leading from said oil reservoir to the oil cups of the crank shaft bearings.

303,084. PISTON VALVE, *H. Herman Westinghouse, Pittsburg, Pa.—Filed April 10th*, 1884.

Claim.—(1) The combination, substantially as set forth, of a main or distribution valve composed of two hollow pistons connected by a tubular body, and packing rings sprung into peripheral recesses in the pistons, each of said rings having a groove on one side fitting against a seat which communicates by a passage with the interior or exhaust side of the valve, and being exposed on its opposite side by a circular

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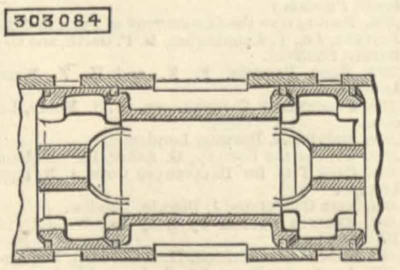

recess cut in the valve to the pressure on the steam side thereof. (2) The combination, substantially as set forth, of a hollow piston valve having circumferential packing recesses, which are grooved or relieved on one side and communicate on the other side by a passage or passages with the interior of the valve, and packing rings which fit in the packing recesses, and are provided with grooves communicating with the passages therein.

303,281. LUBRICATOR, *Ross J. Hoffman, Binghamton, N.Y.—Filed June 3rd*, 1884.

Claim.—(1) The mixing chamber, in combination with the valve chamber, oil cup, and steam and oil ducts, substantially as described. (2) The mixing chamber, in combination with the valve chamber, oil cup, oil duct, and steam tube *d*, opening into steam pipe, as described. (3) A mixing chamber, in combination with a valve chamber, with the orifice between

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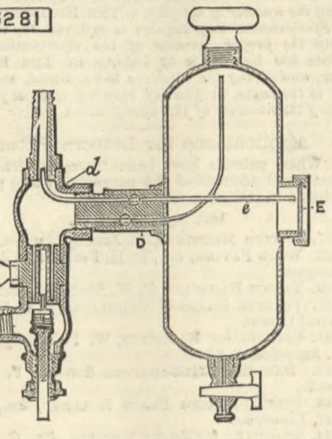

the two regulated automatically, the oil cup, oil duct, and steam tube opening into steam pipe, as described. (4) The oil cup, formed with boss on its side for connection with shank D, combined with the tube *e* and sight-feed E, as described.

303,317. SWITCH CAM AND FOLLOWER, *Freeland W. Ostrom, Bridgeport, Conn.—Filed January 7th*, 1884.

Claim.—(1) A switch cam having splines upon which the follower rides, and a frog or frogs at the intersection of the splines, as described, and for the purpose set forth. (2) A switch cam having splines upon which the follower rides, grooves both sides of the splines, and a frog or frogs at the intersection thereof, substantially as described. (3) A follower for switch cams, having wings upon the head thereof, with an open space between them, as described, and for the purpose set forth. (4) A follower for switch cams, having two wings upon the head thereof, and a longitudinal cut between the wings, whereby the wings are made

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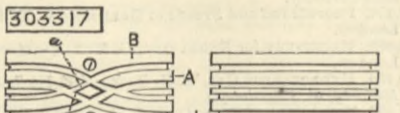

adjustable by a set screw to compensate for wear. (5) A switch cam having splines upon which the follower rides, and a frog or frogs at the intersection thereof, in combination with a follower having wings upon its head, which bear upon opposite sides of the spline. (6) A switch cam having splines A, one or more frogs B, and grooves A^1, *a*, and *b*, in combination with a follower having shank F and head G, with wings H, as described, and for the purpose set forth.

303,357. INCANDESCENT ELECTRIC LIGHTING, *Charles F. Beck, Paris, France.—Filed July 5th*, 1884.

Claim.—(1) The hereinbefore-described improvement in the art of electric lighting, which consists in passing an electric discharge through previously-comminuted particles of solid material in a confined inert atmosphere, substantially as set forth. (2) The hereinbefore-described improvement in the art of electric lighting,

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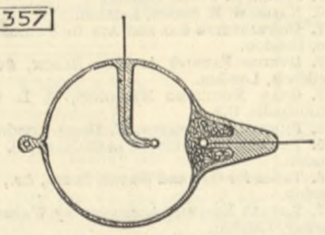

which consists in supplying to the path of an electric discharge in a confined inert atmosphere previously comminuted particles of solid material, such supply being established and maintained by the action of the discharge itself, as set forth.

303,408. GRAPPLING HOOK, *Joseph F. Wheeler, Wyocena, Wis.—Filed March 6th*, 1884.

Claim.—(1) As a new article of manufacture, the device herein described for lifting tubes or shafts vertically, consisting in the spirally-curved plate or hook A, adapted to surround and engage upon the periphery of the tube to be elevated, provided with a lifting chain I, substantially as set forth. (2) The

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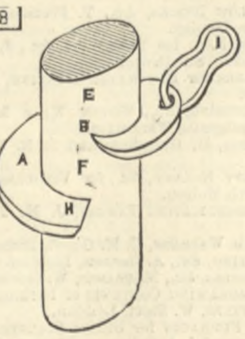

combination of the spiral-shaped plate or hook H, having inward-projecting edge B, adapted to engage in the surface of the tube opening F, for the admission of the tube E, and chain I, attached to the upper coil of said spiral hook, substantially as and for the purpose specified.

303,375. FAN BLOWER, *Miles C. Huyett, Detroit, Mich.—Filed February 23rd*, 1884.

Claim.—(1) In a fan wheel, the combination of a solid disc having an opening in the centre thereof to

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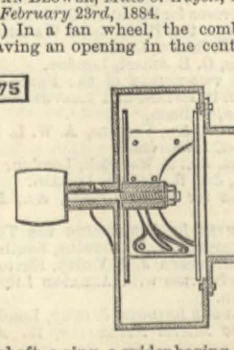

receive the shaft, a ring, a spider having a central hub placed close to said solid disc and extending only partially across the width of the wheel, and also having extending arms, and blades secured to and between said solid disc and ring, and also secured to said spider, and cut away from the outer end of the hub of said spider to the inner edge of said ring, substantially as shown and described. (2) A fan wheel composed of blades secured between a solid disc and a ring, in which said blades are cut away for a portion of their width opposite the opening in said ring, substantially as shown and described.

303,503. SUSPENSION WHEEL, *Henry C. Gallup, Wilmington, Ohio.—Filed October 6th*, 1883.

Claim.—(1) The combination of the tubular hub having at opposite ends the right and left screw threads, in combination with the double discs on each end, one of said discs having at suitable intervals projecting lugs to hold the spokes or suspension wires, substantially as herein set forth. (2) The combination of the double discs on opposite ends of the screw-threaded hub, one or both of said discs having projecting pins or lugs, with the spokes or suspension wires, substantially as herein set forth. (3) The combination

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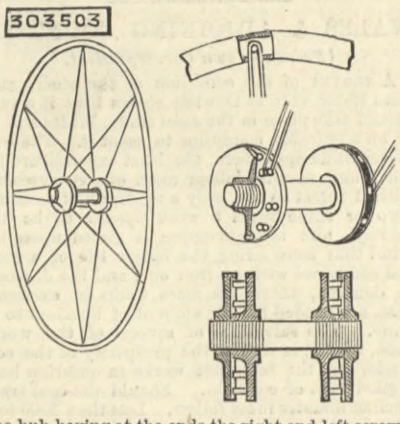

of the hub having at the ends the right and left screw threads, the double discs at each end screwed thereon, having projecting lugs, the continuous wires provided with suitable eyes at intervals, and with the tubular rim slotted to receive the suspension wires, and the cross-pins, substantially as herein set forth.

303,527. ATMOSPHERIC CAR BRAKE, *George B. Leonard and Lawrence Glenn, Ottumwa, Iowa.—Filed February 26th*, 1884.

Claim.—(1) In an air brake, the combination, with the valve chamber and piston valve therein having a leak passage through it, of a power cylinder having connections from both its ends to the valve chamber, so located and arranged as to bring one or the other into communication with the leak passage as the valve is at the extremities of its movement. (2) In an air brake, the combination, with a power cylinder and auxiliary storage cylinder, of an interposed valve chamber and piston valve having a passage through it to communicate with the storage cylinder when the pressure is on from the engine, and a transverse

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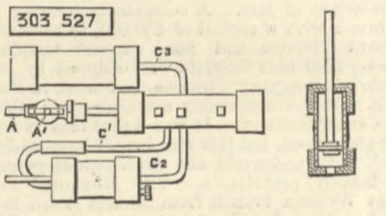

passage directly through it to produce communication between the storage and power cylinders when the pressure from the engine is cut off. (3) The valve described, having the passage F^5, for connecting pipes A and C^1, the passage F^2, for connecting the pipes C^2 and C^3, the passage F^3, for connecting main pipe A and pipe C^3, and the passage F^4, for connecting either of the pipes C^1 or C^2 with a leak hole. (4) In an air brake apparatus, the stop-cock A, located in the main pipe in front of the valve or air cylinder for controlling or shutting off the flow of air, as herein set forth.

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