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

By GENERAL NICHOLAS KALAKOUTSKY.

No. II.

*Method of determining internal stresses and the general arrangement of the work.*—The following is the principle upon which I based my investigations into the internal stresses:—Let us imagine a disc cut from a cylinder which is not subjected to external pressures, but in which we suspect the existence of internal stresses. If such exist, then they will vary in magnitude according to the length of the radius at the extremity of which they may be acting. These stresses give rise to pressures on the cylindrical surface, defined by the given radius, and they act internally in a direction normal to this surface, and generally vary in value according to the position of the surface in the disc. If we cut out of this disc an external or an internal ring, then, since the external pressure which acted on it in its previous state has been abolished by that operation, an alteration in the length of radii will take place; in other words, the disc and the ring will either contract or expand, and the amount of stress which existed in the disc previous to cutting out the ring will be determined by ascertaining the corresponding alteration in the length of the radii.

From the above statement of the fundamental principle, it follows that the work to be done consists in the accurate measurement of the variation in the length of radii caused by the removal of pressures previously existing in the metal of the disc. And as the molecular movement which takes place is always within the elastic limits, it follows that this movement must manifest itself, both as to intensity and extent, in proportion to the elasticity of the metal. Thus, for instance, steel, under various conditions of treatment, and cast iron, rapidly cooled after casting, suffer severe strains, while in the so-called soft metals, such as copper and some qualities of wrought iron, internal stresses cannot attain any considerable magnitude. We must also bear in mind that in the hardest steel elongation corresponding to the elastic limit does not exceed 0·0025, while in cast iron it rarely attains 0·0008; hence the variations in length to be observed and measured are exceedingly minute, and yet from these we have to compute the pressures and the existing internal stresses. It is evident therefore that measurements must be made with extreme accuracy, for in the majority of cases we have to deal with absolute quantities not exceeding hundredths ($\frac{1}{100}$) of a millimetre.

FIG. 3

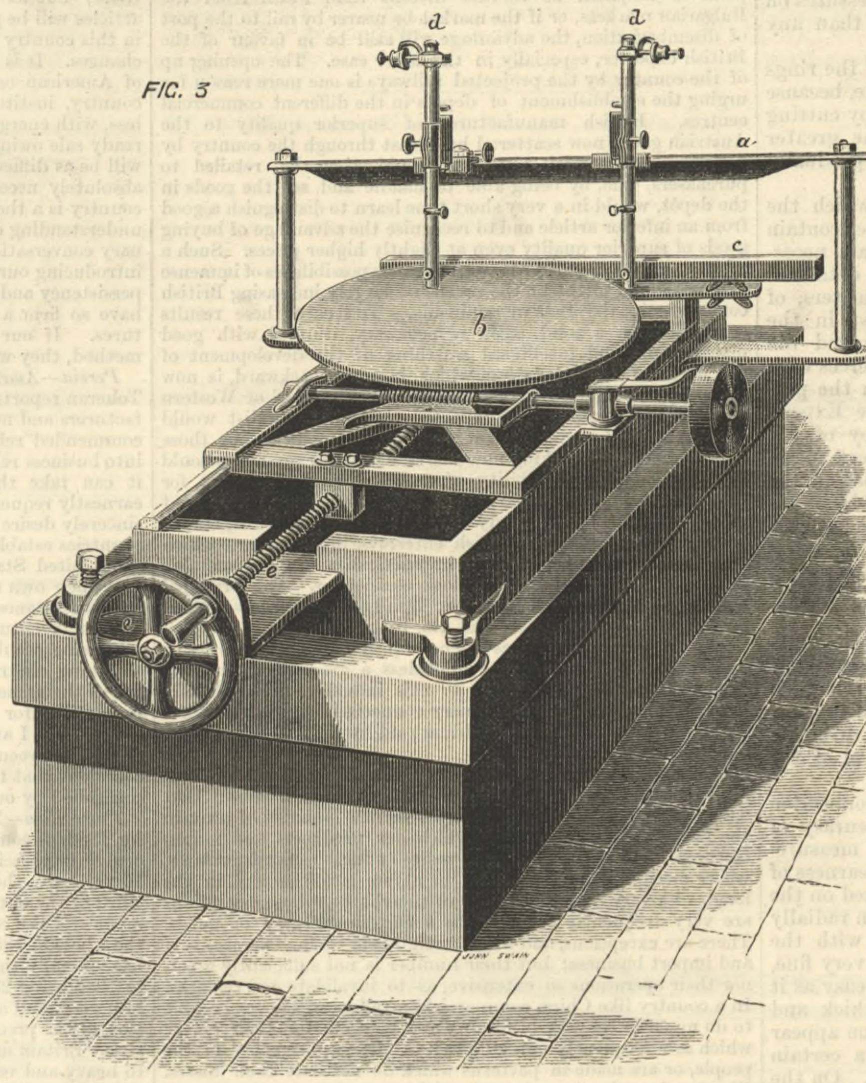
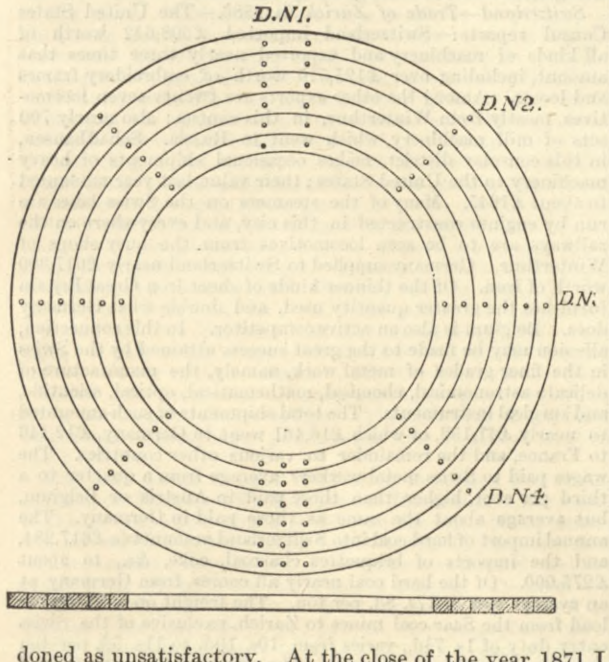



Fig. 4.




At first I used the cathetometers usually employed for determining elongation within the elastic limits of samples tested for tensile strength in an ordinary machine. In using these instruments it was necessary to fix the discs to be tested in a vertical position, and to employ two instruments, taking the readings on two scales. This caused so much trouble and inconvenience that the results of the first experiments had to be abandoned as unsatisfactory. At the close of the year 1871 I designed an instrument specially adapted for the work in view. It was made for me by the late George Brauer, one of the best makers of instruments of precision in Europe. The apparatus, a perspective view of which is given in Fig. 3, is very simple, and consists of a horizontal T-shaped beam *a*, along which traverse slides fitted with clamp sockets, which support in a vertical position two microscopes *d*, furnished with Ramsden's micrometers. The clamps with the microscopes are free to slide along the beam, but when observations are being taken they are fixed immovably. The disc to be experimented upon is placed on a platform or table *b*, which is capable of being either revolved round its axis, to permit proper adjustment of the disc, or fixed immovably. The platform can also be moved longitudinally at right angles to the microscope rail by means of the screw *e*, and it can be raised or lowered by means of three screws placed underneath. A scale is placed in a detached box *c* secured to the same slide which carries the platform *b*, and which can be brought into a position parallel to a line drawn through the optical axes of the microscopes. On commencing an experiment the upper surface of the disc is adjusted to the same level as the scale, to facilitate which the platform on which the disc lies is lowered or raised. The eye pieces of the microscopes are so adjusted that one division of the micrometer shall be equal to 0·001 millimetre, and this reading is verified at the commencement of each experiment. Ten-thousandths (0·0001) of a millimetre are estimated by inspecting approximately the position of the divisions on the head of the micrometer screw relative to the index. When the disc is brought under the microscopes, and they are approximately adjusted over the points which determine the diameter to be measured, then the platform and the clamp sockets of the microscopes are fixed, and the final adjustment of the hairs over the points is performed by means of the micrometer screws. After this the platform and disc are moved back, and by the same movement the scale is brought under the microscopes. In order to repeat an observation already made, there is no need to alter the position of the microscopes; it is sufficient to advance the disc once more, and afterwards the scale.

The scale used by me was divided into half-millimetres, and verified by the Paris standard metre.

The accuracy of the measurements made by means of my instrument would have been quite sufficient for the purpose, if all the observations could have been made at a constant temperature; but with the climate of St. Petersburg this is very difficult to obtain, and in my case it was even impossible, because it was frequently necessary to transport the instrument from one workshop to another, and not all of them possessed arrangements for maintaining a constant temperature. The variations of temperature, however, had a great influence on the accuracy of the results obtained. The measuring scale was of silver, and the discs examined were mostly steel or cast iron. The coefficients of linear expansion of silver and steel are not the same, and as the correction for temperature depends upon the difference between these coefficients, it was essentially necessary to determine their exact values. For this purpose I consulted the works of well-known scientists, such as Laplace, Lavoisier, Smeaton, Roy, Troughton, and others. I found that very few experiments had been made on the expansion of silver. Its coefficient of linear dilatation as determined by various experimenters ranges from 0·000019 to 0·000020826. The expansion of iron and steel has been more fully investigated, notwithstanding which there is even a greater variation in the values of the coefficients, viz., from 0·000009 to 0·000012583. In the face of such discrepancies, I was obliged to undertake a series of rather extensive experiments, from which I have been led to adopt for my calculations the value 0·00001, as the difference between the coefficients of expansion of silver and steel for 1 deg. Centigrade. All the results given in the tables, which will appear in a subsequent impression, are corrected to 15 deg. Centigrade, *i.e.*, to the mean temperature at which the observations were made.

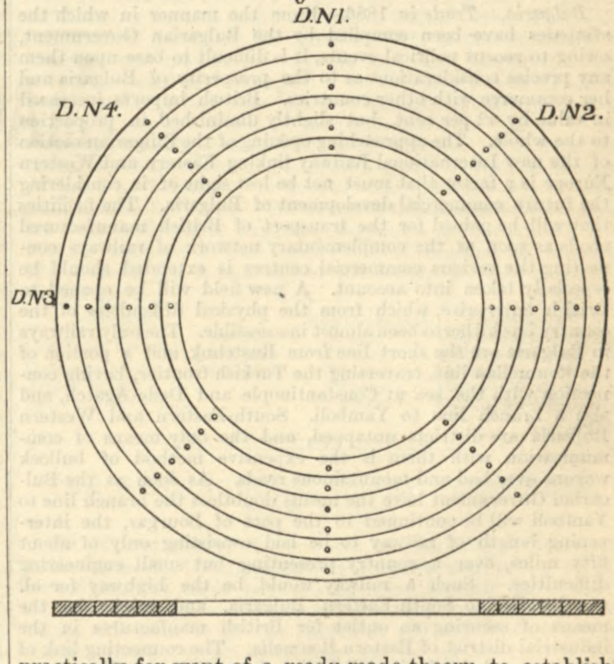
I was not able to cut up the discs investigated into as many concentric rings as I would have wished, because the width of the cuts made by the parting tool ranged from 2½ to 4 millimetres in discs 1in. thick. Usually from six to twelve concentric rings were obtained, the number varying according to the diameter of the disc and the thickness of metal; but where the discs were small, or where the metal in the radial direction was thin, from two to four rings only were obtained, and even that with difficulty.

In every ring not less than four diameters were measured, and sometimes even six. These diameters always intersected at equal angles. The necessity for the great number of measurements which were taken in each ring arose from the circumstance that not unfrequently the rings on being cut out assumed an elliptic form; it was therefore necessary to eliminate the error arising from such distortion by means of average values obtained by measuring several diameters in the same ring, and this was the more necessary because the major and minor axes of the ellipses in different rings were found to vary in direction.

Figs. 4, 5, 6, show in what manner the discs were cut up and the diameters marked out. In the first set of experiments the discs were cut up at once into the full number of rings. In the second series the concentric rings cut out of the disc were turned and bored in a lathe in order to ascertain whether they possessed any permanent internal stresses. A third set of experiments consisted in cutting the individual rings along one of the diameters—generally one lying between the diameters Nos. 1 and 2 on Figs. 5 and 6, or between the double line of points shown on Fig. 4 along diameter No. 1. In these experiments the greatest changes in the length of radii were observed. These were sometimes so great that they exceeded the elongations corresponding to the elastic limit, as for instance in the case of cast iron—*see* Table 8—where the relative value of the changes was found to be 0·002. During these experiments there occurred several cases which afforded, one may say, ocular demonstration of the existence of energetic internal forces in the metal of a comparatively thin ring. Thus, for instance, some rings, whilst being cut through transversely, contracted to such an extent as to jamb the cutting tool, and it was even necessary, in order to liberate it, to file out a piece of the metal. Several instances also occurred when the rings during the operation of cutting broke up spontaneously in two, and even three places. Such was the case in the experiments with forged and hardened steel shell.

Although this method of investigation brought to light very characteristic peculiarities, I did not continue it, chiefly because the rings on being cut through became greatly distorted, and were frequently irregular and wavy, which rendered the taking of the measurements very complicated, while the results obtained could not be used practically for want of a ready-made theory, to establish which fresh experiments would have been necessary, and would only have diverted me from the main object in view.

Fig. 5 & 6.




The method of investigation finally adopted was as follows:—I commenced by marking on the discs the number of rings which I intended to cut out, the diameters along which I proposed to make my measurements, and the points on each ring to be measured, and as it was difficult to make fine lines on steel or cast iron, I was compelled to insert silver plugs at the points of measurement, and mark my fine lines on them. I then determined and recorded the lengths of the several diameters, after which the rings were cut out in succession, either from the outside of the disc or else from the inside, and I then took measurements of all the diameters, both in the cut-out rings and also in the uncut portions of the disc. This operation was very slow and tedious, as may be inferred from the circumstance that in the investigation of a disc from the inner tube of an 11in. gun, which was cut into twelve rings, each of which was measured on four diameters, more than 600 observations had to be made, and the experiment occupied more than two months, including the time expended in cutting out the rings. But, notwithstanding the slow progress of the work, this mode of proceeding is preferable to all others, because it allows of a more exact determination of the pressures on the external and internal radii of the rings than any of the methods first described.

When the method of successive cutting out of the rings is adopted, it is best to commence from the inside, because more accurate results are thus obtained than by cutting the rings from the outside, on account of the greater number of measurements being made on gradually increasing diameters.

In all, I made eighty-seven experiments, of which the most characteristic are alone given. The tables contain only the final results, which embrace all the data necessary for computation. I omit the preliminary details of the work, such as the readings of the micrometers, of temperature, &c. These data would not assist in the study of the subject, but would uselessly extend the tables. For those who desire to acquaint themselves with the details of the work and the various steps in the proceeding, I have compiled a complete table—see Experiment 79—which, in reality, is an extract copy of the journal kept during the experiments. The tables explain themselves sufficiently. I will only mention that in the third column, under the heading, "Change which has taken place," is shown the absolute difference between the diameters when first measured and after their alteration. The sign + (plus) signifies that the layer expanded, and − (minus) that it contracted. The quantity $\frac{\delta}{r''}$ expresses the ratio of the alteration produced, and is accompanied by a sign contrary to that which was given in the results of the measurements. This indicates that, in reality, in the particular ring, previous to its being cut out of the disc, there existed a strain opposite in direction to the one found by experiment after the removal of the pressure on its external surface.

In conclusion, a few words must be said in connection with certain circumstances which affect the accuracy of the observations. For example, the exactness of measurements depends greatly upon the fineness and clearness of the points observed. These points were indicated on the disc by the intersection of two lines, one drawn radially through the centre and the other concentric with the circumference. To obtain lines which shall be very fine, and at the same time clearly visible, is not so easy as it may appear at first sight. If the lines are thick and well defined, then the points of their intersection appear coarse under the microscope, and give rise to a certain error, when the cross hairs are adjusted to them. On the other hand, very fine lines become mixed up with others in their vicinity, and are difficult to distinguish. It is very important, also, to preserve the lines marked out from becoming obliterated during the operation of cutting the disc into concentric rings. This occurred frequently, and several measurements had to be abandoned before the series was complete, in consequence. Sometimes the damage done was, in reality, extremely slight; yet it very much hindered the progress of work, because it was so difficult to distinguish the points which had been marked out.

## ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS.

*Bulgaria.—Trade in* 1886.—From the manner in which the statistics have been compiled by the Bulgarian Government, owing to recent political events, it is difficult to base upon them any precise considerations as to the prosperity of Bulgaria and her commerce with other countries. British imports increased in value by 42 per cent., but slightly diminished in proportion to the whole. The approaching opening of the Bulgarian section of the new International Railway linking Eastern and Western Europe is a factor that must not be lost sight of in considering the future commercial development of Bulgaria. The facilities that will be gained for the transport of British manufactured goods as soon as the complementary network of railways connecting the various commercial centres is extended should be especially taken into account. A new field will be opened to British enterprise, which from the physical difficulties of the country has hitherto been almost inaccessible. The only railways in Bulgaria are the short line from Rustchuk and a portion of the Roumelian line, traversing the Turkish frontier, having connection with the sea at Constantinople and Dede-Agatch, and also a branch line to Yamboli. South-Eastern and Western Bulgaria are districts untapped, and the only means of communication with them is the expensive method of bullock wagons over bad and mountainous roads. As soon as the Bulgarian Government have the means doubtless the branch line to Yamboli will be continued to the port of Bourgas, the intervening length of railway to be laid consisting only of about fifty miles, over a country presenting but small engineering difficulties. Such a railway would be the highway for all merchandise to South-Eastern Bulgaria, and might be the means of securing an outlet for British manfactures in the industrial district of Eastern Roumelia. The connecting link of railway on the Salonica-Nisch line from Uscup to Vranja has been completed, though not opened for traffic. This line, in conjunction with the main line from Nisch to Sofia, presents another means of communication from the sea to Southern and Western Bulgaria. This route is not so favourable as that from Dede-Agatch, since the railway rates on the Roumelian line are very low, and the actual distances from Dede-Agatch and Salonica to points in Western Bulgaria are approximately equal. It is hoped that the British importer will in a short time have a choice of three railway routes to points in Southern and Western Bulgaria, the selection of which should mainly depend on the mileage distance of the port of disembarkation from the point for which his goods are destined. In the Danubian district, owing to the great facilities of water transport possessed by Austria, her trade alone entirely swamps the British. In Southern and Western Bulgaria the British manufacturer, from the point of view of transport, will be best able to compete with his Austrian or Hungarian rival. The distance of the nearer Austrian mercantile centres, such as Pesth, from the nearest points in Western Bulgaria is from 150 to 180 miles greater than the distance from the same points to the sea *viâ* Dede-Agatch or Salonica; and with the present low rates for freight by sea, and the high tariff for transport of merchandise by rail, the British manufacturer should have no difficulty in sending his goods to those ports at equal or smaller cost by sea than his Austrian competitor by land, and so outbidding him by the superior quality of his goods. If the point of despatch be further distant than Pesth from the Bulgarian markets, or if the market be nearer by rail to the port of disembarkation, the advantage will still be in favour of the British exporter, especially in the latter case. The opening up of the country by the projected railways is one more reason for urging the establishment of depôts in the different commercial centres. British manufactures of superior quality to the Austrian goods now scattered broadcast through the country by Austrian commercial travellers could then be retailed to purchasers, who, by being able to handle and see the goods in the depôt, would in a very short time learn to distinguish a good from an inferior article and to recognise the advantage of buying goods of superior quality even at slightly higher prices. Such a scheme properly carried out would possess possibilities of immense extension, and might be the means of largely increasing British commerce in the Balkan peninsula. To secure these results enterprise on a solid basis is necessary, coupled with good management and intelligent watching of the development of the needs of the population, which, however backward, is now gradually awakening to Western ideas and the need of Western civilisation. It cannot be expected that any capitalist would embark in such a venture at the present moment, but those British merchants seeking new markets for their products should bear in mind the possibility of an ever-increasing outlet for British commerce in Bulgaria, and when the favourable moment occurs they should be ready to avail themselves of it, and so secure the supremacy of British enterprise in Bulgaria, to which access has hitherto been almost impracticable. In the metallic industry Austria is the only serious competitor. The principal British imports in this branch are iron bars and girders, metals in the rough, rough copper and tin, tin-plates, &c. In proportion as the country becomes opened up by increased facilities of communication there will be doubtless a gradually increasing demand for articles pertaining to this industry, and especially for all implements and machinery connected with agriculture. Attention to this subject should be paid by the iron industry in Great Britain.

*China—Developing American trade with.*—The United States Minister at Pekin reports:—It has long since been shown that one of the chief impediments to opening new branches of trade in the East was the ignorance in which our producers and manufacturers were of the needs and tastes of these remote countries, where foreign trade is centred in a few localities and in the hands of a very limited number of merchants, whose operations are very frequently confined to a certain category of goods. There are exceptions, and some foreign firms do a general export and import business; but their number is not sufficiently great, nor their operations so extensive, as to invalidate my remarks. In a country like China commercial travellers will never be able to do much in the way of finding new markets for their goods, which are frequently not adapted to the requirements of the people, or are made in patterns which do not suit their tastes. We already make a number of articles, especially for the Chinese markets, but the list of such goods might be increased if our manufacturers were better acquainted with the wants of the market, and could make articles or patterns already adopted by the Chinese, and if they were in possession of such information as would enable them to regulate their prices so as to compete with the native producer, as, for instance, in hardware. Chinese hardware, though cheaper, is of a very inferior quality, and our manufacturers, if they knew the tastes of the Chinese, could produce articles far superior in quality, and at such low prices that they could easily compete with the native goods in the Chinese markets. The importance of bringing the manufactures and products of remote countries under the eyes of home manufacturers and merchants has for many years been appreciated by some of the European Powers which have commercial interests in the East, and they have made efforts to remedy this want. At least twenty-five or thirty years ago the French Government found that the establishment in Paris of a permanent exposition of the manufactures and products of its remote colonies was highly advantageous to the development of trade. More recently many of the Consular officers of Germany have been collecting specimens of the manufactures and products of their districts, and also of the foreign manufactures for sale in the native markets, and forwarding them to different localities in the German Empire, there to be exposed to the public. The Consuls had sent with these samples such detailed descriptions as might enable interested parties to ascertain if they could possibly compete advantageously with the native manufacturers in their own markets. Different Chambers of Commerce have defrayed the expense of purchasing and forwarding these goods—expenses which have never been considerable—and have provided room for their exhibition. The German Government has not been called upon to make any allowances or incur any expense in accomplishing this result. A short time ago Belgium adopted an analogous plan, and has opened in one of her chief manufacturing centres an exposition of the manufactures and products of the far East. Last year the French syndicate having its head-quarters at Tien-Tsin opened at that place an exposition of French manufactures for the information of the Chinese, and their plan has already borne fruit. Some plan analogous to that followed by Germany might prove beneficial to the development of our trade with China. Our Consular officers in China would be well pleased with their share of the work, and give this further proof of their earnest desire to develope trade between China and the United States.

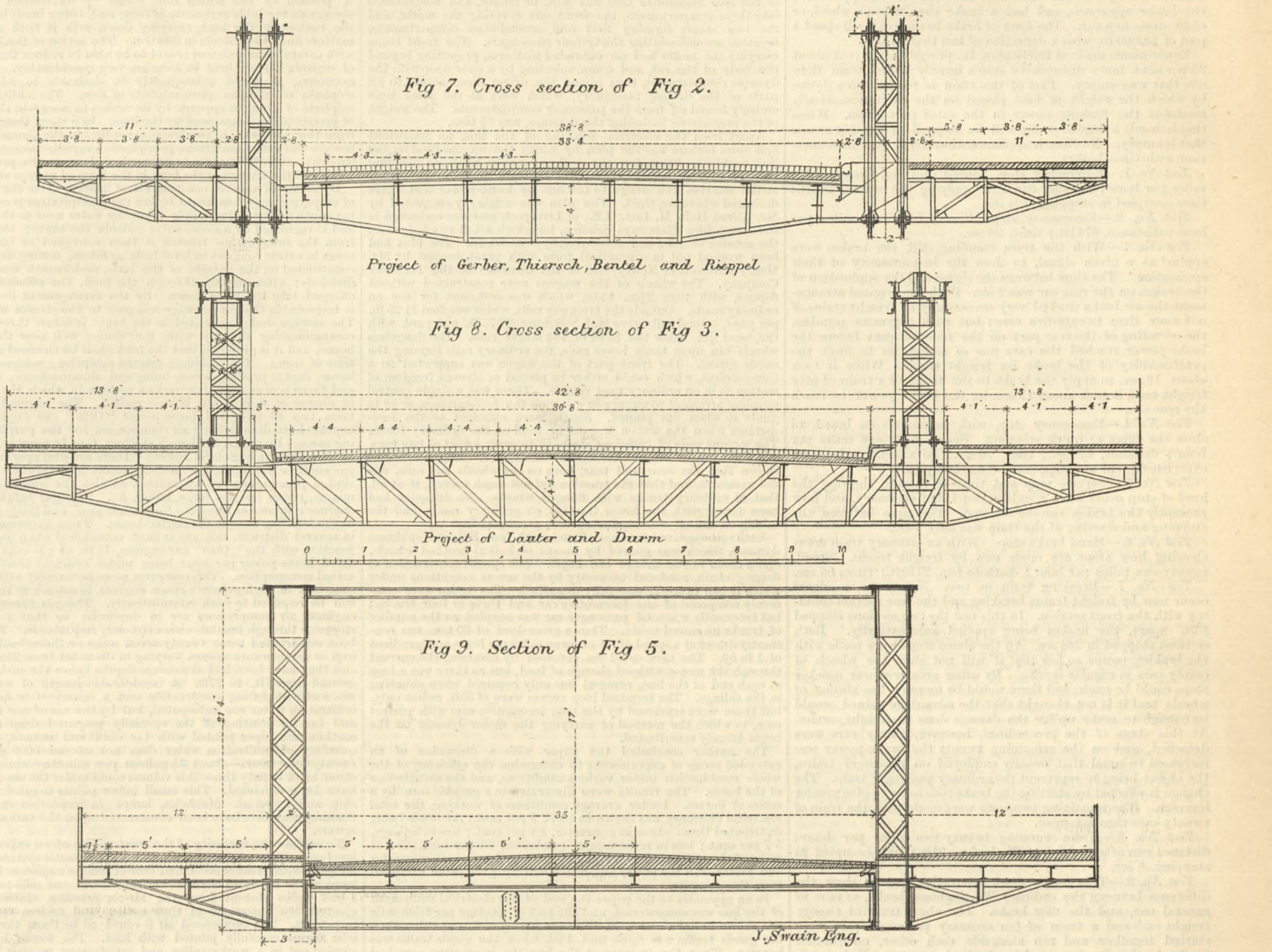
*Germany.—American goods in Gera.*—The United States consular agent at Gera reports:—The retrogression which the trade in American goods has experienced of late years in this region, induces me to commend some suggestions to the attention of our manufacturers and traders. The high standard of American goods previously securing an extensive demand has not now been maintained; as a consequence, their consumption has naturally decreased and is a very limited one. To regain a lost market is one of the most difficult problems, therefore our merchants ought to exercise the greatest care and conscientiousness concerning the character of their shipments. The trade with our cheap and excellent products is capable of great extension when conducted in the proper way. As to our manufactures, many Americans suppose that because they have an article of undoubted merit, and generally acknowledged to be such at home, that it is an easy matter to sell it in foreign markets, and needs only the transmission of circulars and price lists to attain this object. Comparing the tastes and wants of Americans with those of other countries, this supposition is a very erroneous one. A mechanic in the United States will promptly and unhesitatingly discard a tool he has in use for something better adapted to his requirements. To assume that a German mechanic is equally progressive is a great mistake. To gain a foothold in foreign markets it is indispensable to enter into a careful study of the customs, habits, needs and tastes of those desired as customers. Then, it is necessary to have agencies established supplied with articles best suited to the wants of the people, and sold at a moderate profit. There may be a drawback to such an undertaking from the competition of cheaper and inferior imitations; but as the best proves the cheapest, so our superior articles will be given the preference in the long run. The people in this country are slow in adopting novelties, and distrustful of changes. It is also easy to excite a prejudice against an article of American origin, owing to the limited knowledge of our country, institutions, manufactures and products. Nevertheless, with energy and perseverance our manufactures will find a ready sale owing to their superior quality, and, once introduced, will be as difficult to supplant as were their predecessors. An absolutely necessary requisite for an American agent in this country is a thorough knowledge of the German language; an understanding of a foreign language, so as to carry on an ordinary conversation, is not sufficient for the purpose of successfully introducing our merchandise. It is unquestionably due to the persistency and push of the merchants of this district that they have so firm a footing in the United States for their manufactures. If our merchants would apply the same systematic method, they would be equally successful.

*Persia—American trade with.*—The United States Minister at Teheran reports: I am constantly receiving letters from manufacturers and merchants in the United States asking to be recommended reliable parties here with whom they could enter into business relations. This legation does not know of any that it can take the responsibility of recommending, and I am earnestly requested by Persians in the highest positions, who sincerely desire to see the commercial relations between the two countries established on a sound basis, to advise that firms in the United States desiring to enter this market should send over their own agents to represent them; and that they, under no circumstances, choose as their representatives European or foreign adventurers on the spot, who, under the pretence of possessing peculiar facilities for doing business, and especially for obtaining contracts from the Government, seek to obtain the use of the names of the said firms as a sort of guarantee of responsibility for the purpose of promoting private schemes of their own. I am confident that a lucrative trade can be established between the United States and Persia, but I am equally confident that to make it successful it must be originated and controlled by our own people at both ends of the line.

*Porto Rico—Trade in* 1886.—The import trade of the island for 1886, as compared with 1885, shows a falling off of 5½ per cent. British imports have increased during that period by 16 per cent., the total value being estimated as being about one-third of the entire import from all countries. This is an improvement of 6 per cent. upon the position held by British goods to the whole in 1885, and gives them the first place. Great Britain has virtually the monopoly of the trade in metals, her imports in 1886 being 2304 tons, or 84 per cent. of the total quantity imported, and an excess of forty tons over the entire importation of the preceding year. Coal is virtually a British monopoly, Great Britain and the Colonies supplying 92 per cent. Owing to heavy and vexatious taxation, and the unequal competition in Europe with bounty-fed beet-root sugar, the sugar industry in this island is in a serious state, and unless drastic measures are forthwith taken, in the form of an extensive reduction in taxation, to remedy the difficulties under which cultivators labour, the ruin of the sugar-cane industry may ere long be expected. The road from St. John's to Ponce *viâ* Caguas and Coamo is all but completed. This is the only really good main road in Porto Rico; but four others have been commenced, and plans have been made for four more. The want of well-made roads is a serious hindrance to the proper development of the resources of this country, and it is to be hoped, in the interests of commerce, that sufficient money will be speedily forthcoming, so as to enable the works already entered upon to be satisfactorily completed. The long contemplated cleaning and improving the port of St. John's has not yet been commenced, and much inconvenience to shipping will shortly be experienced if the work of dredging is not taken energetically in hand.

*Switzerland—Trade of Zurich in* 1886.—The United States Consul reports:—Switzerland imported £308,642 worth of all kinds of machinery and exported nearly three times that amount, including over £125,510 worth of embroidery frames and looms. Among the other exports are twenty-seven locomotives, mostly from Winterthur, in this canton; also nearly 700 sets of mill machinery, which went to Russia. Schaffhausen, in this consular district, makes occasional shipments of heavy machinery to the United States; their value last year amounted to about £1645. Many of the steamers on the Swiss lakes are run by engines constructed in this city, and everywhere on the railways are to be seen locomotives from the busy shops of Winterthur. Germany supplied to Switzerland nearly £617,300 worth of iron. Of the thinner kinds of sheet iron Great Britain furnishes the greater quantity used, and double what Germany does. Belgium is also an active competitor. In this connection, allusion may be made to the great success attained by the Swiss in the finer grades of metal work, namely, the manufacture of delicate astronomical, chemical, mathematical, optical, scientific, and surgical instruments. The total shipments of such amounted to nearly £41,152, of which £16,461 went to Germany, £12,146 to France, and the remainder to various other countries. The wages paid to Swiss metal workers average from a quarter to a third per cent. higher than those paid in Austria or Belgium, but average about the same as those paid in Germany. The annual import of hard coal into Switzerland amounts to £617,284, and the imports of briquettes charcoal, coke, &c., to about £275,000. Of the hard coal nearly all comes from Germany at an average cost of 17s. 8d. per ton. The freight on a 10-ton car load from the Saar coal mines to Zurich, exclusive of the Swiss entry duty of 1s. 7¼d., varies from 10s. 10d. to 11s. 5d. per ton according to place of shipment. The efforts of Germany to send her coal across Switzerland to Italy, *via* the St. Gothard, have thus far met with little success. Of Italy's £535,000 coal import England furnished £463,000, and Germany only £14,403. Taking a general survey of the commercial and industrial situation in this section of Switzerland, we find everywhere present and dominant the determined pressure of German competition and enterprise flooding the land with all classes of her manufactures and products, and in most cases at the ruinous prices which eventually follow over-production.

# TRANSVERSE SECTIONS OF MANNHEIM BRIDGE DESIGNS.




## NEW BRIDGE AT MANNHEIM — COMPETITIVE DESIGNS.

THE suspension bridge at Mannheim which was erected in the year 1840-45 no longer suffices for the large traffic from one side of the river to the other. The foundations of the piers, moreover, are believed to be uncovered by the continual deepening of the Neckar channel. The Government of Baden therefore offered premiums for the best design for a new bridge under the following conditions.

The position of the new bridge must be the same as that of the existing bridge, the road may be raised from 1ft. to 2ft., the present breadth of the road, 18ft., to be extended to from 34ft. to 36ft. Each footpath must have a breadth of 12ft., and neither wood or macadam will be allowed in the construction of the road. Neither road nor river traffic to be stopped or obstructed during the erection of the bridge. In the channel there must be two openings, each at least 50ft. wide, and the head room be the same as now. During the construction, from the first of December to the last day of February no stage is allowed in the channel, and the erection of the bridge must not take more than three years. If the present piers are utilised they must be protected against the underscour of their foundations. If new piers should be erected, the old ones are not to be allowed to remain at the same time in the channel. Architectural adornment corresponding with the requirements is to be chosen. No construction of iron is allowed lower than 39ft. above Mannheimer water-mark. The cost of the bridge is not to exceed the sum of £56,250. In reply to the invitation eleven projects were sent in, viz:—(*a*) Four projects for cantilever bridges; (*b*) Two projects for continuous girders; (*c*) One for a kind of suspension bridge; (*d*) Two for lattice girder bridges, and (*e*) two for arched bridges. The two first prizes were awarded for cantilever bridges; the third prize was given for a continuous girder bridge. The following is a short description of these three projects, and one of each of the two other systems.

The first design is that by Herren Benckiser, Pforzheim, Bernatz, of Grün, and W. Manchot, of Mannheim. According to this project a provisional wooden bridge with Howe trusses will be erected over the Neckar. Close to the old piers, new ones will be constructed by means of the pneumatic method, and the bridge itself will be put up by means of staging. The road will be paved with granite; under this is concrete, which rests on buckled plates, and the footpaths will have an asphalte pavement. The cost amounts to about £56,250. The weight of ironwork is 1445 tons wrought iron, 34 tons cast iron, and 4 tons steel, or, for the 593ft. length of the bridge, 1483 tons—2·5 tons per foot run. The disadvantages attaching to this design according to Herr Otto Klett, engineer, Cannstatt, from whom we receive our information, are the sinking of the caisson through the old concrete foundation, the narrowness of the bridge, the difficulty of erecting wood bridge, stage, new bridge, and pull-down stage and old bridge in nine months.

The second project is by Herren Gerber, Thiersch, and Beutel, of Munich, and M. Rieppel, of Gustavsburg. This project is for a bridge with two cantilevers, 216ft. long, and one intermediate span, 76ft in length. The ends are anchored in the land piers. The road is 38ft. wide, and paved with granite, carried on Zore's iron and concrete. The footpaths have an asphalte pavement. The old piers will remain, and will be protected by concrete blocks and apron, as shown in Fig. 2, which are sunk by means of pneumatic pressure.

The new bridge will be erected upon staging; the road of the old bridge will be raised about six feet by means of screw jacks, which will temporarily take the place of the present suspension rods. After the completion of the bridge, the old one will be taken to pieces and lifted away. The architecture is very good. The cost amounts to £56,250. The weight of the ironwork is 1620 tons wrought iron, 51 tons cast iron, or for 638ft. length, 2·6 tons per foot length. The objections to this plan are the obstruction of the traffic during the construction.

The third project is by Herr Lauter, of Frankfort, and Dr. Durm, of Karlsruhe. The bridge is continuous, with two openings of 157ft. on both sides of the river, and one middle opening of 313ft. At the shore ends of the girders, where there are sliding supports, concrete blocks are used as counterweights. The road is 43ft. wide, provided with wood pavement over Zore's iron; the footpaths are 13ft. wide, and have an asphalte pavement. Close to the old piers, temporary piers will be set up upon piles, and above them the new bridge will be erected by means of staging, and the old one will be pulled down. In place of the former piers, smaller piers will be built if this plan be adopted, and the new bridge pushed over to its proper place. The architecture of this design is very handsome, and the cost amounts to about £70,000. The weight of the ironwork for 629ft. length is 1859 tons of wrought iron, 214 tons of cast iron, 24 tons of steel, 2097 tons total weight, or per foot length of the bridge 3·33 tons. The objections to this project are the foundations of the provisional piers, the cost and the system of bridge.

A description may now be given of the two other systems that were not so fortunate as to receive a prize. The project by Messrs. Moller, Eckert, and Schmidt, Hamburg, is for an arched girder bridge, the horizontal thrust of the bows being resisted by an elevated braced tie, from which the roadway is suspended. The two arches on the side openings are 162ft. span and the middle arches 309ft. The height of the arches is 25ft. and 43ft. The girder which takes up the horizontal thrust is 8ft. deep. The road is suspended 17ft. below it, and is paved with wood upon a concrete bed which is supported by buckled plates; the footpaths have an asphalte pavement. The erection of the ironwork is to be effected by means of staging. On both sides of these girders are temporary roads which serve for communication during the removal of the old bridge. It is observed of this bridge that the foundation is by no means sufficient and the architecture moderate. The cost amounts to £56,250; the weight of the ironwork is 2040 tons of wrought iron, and 44 tons cast steel, a total weight of 2084 tons, or per foot run of the bridge 633ft., a weight of 3·3 tons. The project last to be described is that of Herr O. Klett of Cannstatt, and Herr Beisbarth, architect, Stuttgart. This project presents a bridge with three openings, two of which are 149ft. span and 22ft. high. They are parallel lattice girders. The middle span is 292ft. long, 37ft. high, with a curved upper boom. The road is 35ft. wide and has an asphalte pavement upon concrete and Zore's iron. The footpaths are 12ft. wide, and have also an asphalte pavement. The new bridge would be erected upon the old piers lengthened, and is proposed to be floated into position upon the piers, which are protected by caissons, concrete filling, and iron piles of channel iron. On the side of the chief girder the temporary roads would be erected, the old bridge removed, and then the new road erected. The cost is about £49,000. The weight for the 625ft. length of the bridge is 1380 tons wrought iron, 117 tons cast iron, and 3 tons cast steel, a total weight of 1520 tons, or per foot length of bridge 2·4 tons. Herr Klett says, "How high developed the sense of form of the members of the jury was may be seen by the fact that this project was not even examined, although it is the cheapest, because the cross section of the bridge was not nice enough, though this cross section is totally covered by beautiful portales." It is to be remarked that all projects which received a prize have departed from the conditions of the competition, and in such a manner as must be surprising to anyone who only has in view the conditions as laid down. The names of the members of the jury are:—Honsell, Seyb, Engesser, engineers at Carlsruhe; Dr. Schäffer, engineer at Darmstadt; Siebert, engineer at Munich. The following is a summary of the weight per foot length of the bridges:—

| System. | | Weight per foot. | Engineers. |
|---|---|---|---|
| Cantilever bridges | 1st prize | 2·5 tons | Blenckiser and others. |
| | 2nd prize | 2·6 tons | Gerber and others. |
| Continuous bridge | 3rd prize | 3·3 tons | Lauter and others. |
| Arched bridge | | 3·3 tons | Moller and others. |
| Lattice girder bridge | | 2·4 tons | Klett and Beisbarth. |

## THE WESTINGHOUSE BRAKE TESTS NEAR NEW YORK.

MR. WESTINGHOUSE, the inventor of the original Westinghouse air brake, having patented an improvement in the brake, embodying the triple valve arrangement, recently had a train of fifty box freight cars equipped with this brake, and has been taking this train to all the important railroad centres of the United States, giving exhibitions of the performance of the brake. With regard to the trials made at New York, our American correspondent, who was present thereat, sends us the following description:—

On November 21st an exhibition was given near New York of the performance of the improved Westinghouse brake. The tests were made at Ridgewood Park, N.J., on the New York, West Shore, and Buffalo Railroad, there being a straight stretch of track two miles in length, with a grade of 53ft. per mile. The train consisted of fifty empty box cars of the ordinary type, 38ft. 4in.

long, with a capacity of 60,000 lb., each car being carried on a pair of four-wheeled diamond trucks, with the brake shoes hung between the wheels. The train was 1900ft. in length, and weighed 2,000,000 lb. It was equipped throughout with the Janney automatic coupler, with a lever for uncoupling without going between the cars. Each car was equipped with the brake apparatus, and had a brake shoe to each wheel, or eight shoes to a car. The form of brake beam used will stand a pull of 25,000 lb. with a deflection of less than ⅛in.

Experiments made at Burlington, Ia., proved that it took about 25 per cent. more distance to stop a heavily loaded train than one that was empty. Part of this train is fitted with a device by which the weight of load placed on the car automatically increases the braking power in the same proportion. When this is used, a loaded train will be stopped as quickly as one that is empty. No electric appliance whatever is used in connection with these brakes.

*Test No.* 1.—Emergency stop. Speed of train, twenty-three miles per hour; distance run after applying the brakes, 203ft.; time occupied in stopping, 12¼ sec.

*Test No.* 2.—Emergency stop. Speed, forty-one miles per hour; distance, 674½ft.; time, 20 sec.

*Test No.* 3.—With the train standing still, the brakes were applied at a given signal, to show the instantaneity of their application. The time between the signal and the application of the brakes on the rear car was 2 sec. With the original arrangement the air brake worked very successfully on freight trains of not more than twenty-five cars; but with a greater number, the crowding of the rear part on the forward part before the brake power reached the cars was so serious as to limit the practicability of the brake for freight trains. While it took about 10 sec. to apply the brake to the front of a train of fifty freight cars, it took about 15 sec. for the brake power to reach the rear car.

*Test No.* 4.—Emergency stop, with passengers on board, to show the effect of quick stopping. Speed, forty-one miles per hour; distance, 672½ft.; time, 20 sec.; no violent jerks were experienced, the stopping being remarkably easy.

*Test No.* 5.—Service stop and time of release, showing the kind of stop made when a sudden stop is not necessary, and how promptly the brakes can be released. The time between the stopping and starting of the train was only 4 sec.

*Test No.* 6.—Hand brake stop. With an ordinary train crew, showing how stops are made now by freight trains. Speed, twenty-one miles per hour; distance run, 2153ft.; time, 85 sec.

*Test No.* 7.—Breaking train in two. Numerous accidents occur now by freight trains breaking and the rear section colliding with the front section. In this test the two sections stopped 43ft. apart, the brakes being applied automatically. Both sections stopped in 26½ sec. All the above stops were made with the braking-power so low that it will not slide the wheels of empty cars in regular service. By using greater power quicker stops could be made, but there would be more or less sliding of wheels, and it is not thought that the advantage gained would be enough to make up for the damage done in freight service. At this stage of the proceedings, however, thirty cars were detached, and on the remaining twenty the brake-power was increased to equal that usually employed on passenger trains, the object being to represent the ordinary passenger train. The change is effected by shifting the brake rods so as to give greater leverage. The remaining two tests were made with the train of twenty cars thus arranged.

*Test No.* 8.—Train running twenty-two miles per hour; distance run after applying the brakes, 91ft.; time occupied in stopping, 6 sec.

*Test No.* 9.—This was a most interesting test to show the difference between the ordinary Westinghouse brake, as now in general use, and the new brake. The above train of twenty freight cars and a train of ten ordinary passenger cars were started together and ran alongside each other, on parallel tracks, to the signal post, when the brakes were applied simultaneously on both trains. At the post the freight train was a few feet ahead. The speed of both trains was forty-five miles per hour; the freight train was stopped in 13½ sec. and ran 495ft., while the passenger train ran 1204ft. In the last two tests the brakes were applied with full force, regardless of sliding wheels, in order to show how quickly a train could be stopped in case of necessity.

# THE INSTITUTION OF CIVIL ENGINEERS.

## ELECTRIC TRAMWAYS.

At the ordinary meeting on Tuesday, December 6th, the paper read was "Electrical Tramways: the Bessbrook and Newry Tramway," by Edward Hopkinson, M.A., D.Sc., Assoc. M. Inst. C.E.

Although a number of electrical tramways had been constructed in the United Kingdom during the last few years, there had hitherto been no attempt at the regular haulage of minerals and goods, nor at the operation of cars larger than the ordinary tramway type. Probably in no case had the effective power of any single motor exceeded about 4-horse power. The principal object of the present paper was to describe the construction and to discuss the working of the Bessbrook and Newry Electrical Tramway, which had been designed for the haulage of heavy goods as well as for passenger traffic. The length of the line was rather more than three miles, with an average gradient of 1 in 86, the maximum gradient being 1 in 50. According to the conditions of the contract, ten trains were to be run in each direction per day, providing for a daily traffic of 100 tons of minerals and goods, and capable of dealing with 200 tons in any single day, in addition to the passenger traffic. The electrical locomotive was to be capable of drawing a gross load of 18 tons on the up journey, in addition to the tare of the car itself and its full complement of passengers, at an average speed of six miles per hour, and a load of twelve tons at an average speed of nine miles per hour; also, the cost of working, as ascertained by six months' trial, was not to exceed the cost of steam traction on a similar line. The line was formally taken over by the company, as having fulfilled the conditions of the contract, in April, 1886, and had since been in regular daily operation. It was worked entirely by water power, the generating station being adjacent to the line at a distance of about one mile from the Bessbrook terminus. There were two generating dynamos of the Edison-Hopkinson type, driven by belting from the turbine shaft, which was extended into the dynamo shed for the purpose. The turbine could develope 62-horse power, and each dynamo was intended for a nornal output of 250 volts 72 ampères, though they were capable of giving a much larger output. The current was conveyed to the locomotive cars by a conductor of steel, rolled in the channel form, laid midway between the rails, and carried on wooden insulators nailed to alternate sleepers. The conductor was not secured, but was simply laid upon the insulators which fitted into the channel, and, while allowing for longitudinal motion to compensate for changes of temperature, held it laterally. At one point the line crossed the county road obliquely, the crossing being 150ft. in length. In this case the conductor on the ground level was not feasible, and an overhead conductor on Dr. John Hopkinson's system was substituted, by which the collector on the car consisted of a bar only, which passed under the supports of the overhead wire, and made a rubbing contact with its under surface. This system had been found to give very satisfactory results in practice.

The locomotive equipment of the line consisted of two passenger cars, each provided with a motor. The body of the car was carried on two four-wheeled bogies, the motor being fixed on the front bogie, so as to be entirely independent of the body of the car. The longer of the two locomotive cars was 33ft. in length, and was divided into three compartments, the front one covering the motor, and the two others forming first and second-class compartments, together accommodating thirty-four passengers. The front bogie carrying the motor had an extended platform, projecting beyond the body of the car, and communicating by a slide door with the dynamo compartment, thus giving the driver direct access to all parts of the driving machinery, which were at the same time entirely boxed off from the passenger compartments. The weight of the locomotive, including the dynamo, was 8¼ tons.

Apart from the electrical working of the line, an important and novel feature was the plan by which the wagons used on the line could also be used on the ordinary public roads, so avoiding the necessity of transhipment, and enabling goods to be loaded at the wharves and drawn to the line by horse-power and again delivered where required. The plan was originally suggested by Mr. Alfred Holt, M. Inst. C.E., of Liverpool, and was embodied in the Lancashire Plateways Scheme, for which a Bill was lodged in the autumn of 1882 and subsequently withdrawn. The idea had been worked out in a practical form with great success by Mr. Henry Barcroft, of Newry, one of the directors of the Tramway Company. The wheels of the wagons were constructed without flanges, with tires 2⅜in. wide, which was sufficient for use on ordinary roads. Outside the tramway rails, which weighed 41·25 lb. per yard, second rails were laid, weighing 23·75 lb. per yard, with the head ⅞in. below the head of the larger rails. The flangeless wheels ran upon these lower rails, the ordinary rails forming the inside guard. The front part of the wagon was supported on a fore-carriage, which could either be pinned or allowed freedom of motion as in an ordinary road vehicle. There was a single central coupling arranged to engage in a jaw on the fore-carriage, so as to guide it when not pinned. Shafts were attached to the fore-carriage when the wagon was to be used on the ordinary roads. The wagons were of sufficient strength to carry a load of two tons, and their weight without the shafts was 23½ cwt. Experience had shown that the wear and tear, both on the wheels and rails, was not excessive, and that the traction did not much exceed, if at all, that of ordinary trucks with flanged wheels. No difficulty had been found with the horse traction on ordinary roads, and the taking on and off was conducted with great rapidity.

Each locomotive car was fitted with an Edison-Hopkinson dynamo, which was geared by means of helical toothed wheels, and a chain to one axle of the bogie. The special construction of driving chain, rendered necessary by the severe conditions under which it had to work, was fully described. The trains were commonly composed of one locomotive car and three or four trucks; but frequently a second passenger car was coupled, or the number of trucks increased to six. Thus a gross load of 30 tons was constantly drawn at a speed of six or seven miles per hour, on a gradient of 1 in 50. The cars could be reversed by reversing the current through the motor without change of lead, but as there was a loop at each end of the line, reversal was only required when shunting in the sidings. The terminal loop curves were of 55ft. radius only, but these were traversed by the long locomotive cars with perfect ease, to which the method of carrying the motor-dynamo on the bogie largely contributed.

The author concluded the paper with a discussion of an extended series of experiments to determine the efficiency of the whole combination under various conditions, and the distribution of the losses. The results were illustrated in a graphic form by a series of curves. Under average conditions of working, the total electrical efficiency was shown to be 72·7 per cent., the losses being distributed thus:—Loss in generator, 8·6 per cent.; loss in leakage, 5·7 per cent.; loss in resistance of conductor, 6·6 per cent.; loss in motor, 7·7 per cent. The friction of the bearings in both generator and motor, and the power lost in the driving gear, were excluded from these results.

In an appendix to the paper the cost of the electrical equipment of the line was summarised, and the cost of haulage per train-mile was shown to have been 3·3d. over one period of five months, when the goods traffic was light, and 4·2d. when the goods traffic was heavier. Since the opening of the line the locomotive cars had registered a train-mileage of 40,000 miles, and the tonnage had exceeded 25,000 tons, and the number of passengers 180,000.

# THE WEDNESBURY SEWERAGE WORKS.

On the 6th inst. a special meeting of the Wednesbury Corporation was held at sewage outfall works, Bescot, for the purpose of inspecting the arrangements and seeing the machinery in motion. Mr. Pritchard, consulting engineer, explained the arrangements of the works, and the processes involved in the purification of the sewage. Gas having been generated by means of Dowson's economic gas system, two Otto's silent gas engines in the engine-house were set in motion, Mr. Holt explaining the principles upon which they worked. The fact was commented upon that this was the introduction of the Dowson system into the district, and it was stated that by this system gas would be produced at about half the cost of gas produced by the ordinary methods, thus effecting a saving of something like £500 a year. Reference was also made to the experimental character of some of heavy expenditure, upon the sludge compressors which were forced upon the Corporation by the action of certain influential residents in the neighbourhood. Before the company separated the Mayor gave "Success to the Corporation Sewerage Works," and bore testimony to the efficiency and completeness of the works, and to the ability, enterprise, and zeal of Mr. Pritchard, the engineer, as well as to the satisfactory way in which the contracts had been carried out, especially complimenting Mr. Law, the contractor.

Wednesbury is a town of some 25,000 inhabitants, situate in the "Black Country"—Staffordshire—between Birmingham and Wolverhampton; and until the present works were commenced the town was without any system of sewers, the sewage of the town being discharged by means of open channels and pipes into the river Tame. In consequence of the action taken by the Birmingham Corporation, as proprietors of the water rights of the river Tame, and to prevent pollution of the same by the sewage, the then Wednesbury Local Board considered it necessary to construct works both for sewerage and sewage disposal; the scheme carried out is one of chemical precipitation, supplemented by land filtration. The system of sewers is a partially separate one, the sewers to convey sewage only; surface water passing direct over the various well-paved channels which the town possesses to the several water-courses. In the construction of the works provision has been made for a much larger population than at present; it is estimated that 625,000 gallons—exclusive of surface or infiltration water—will be the normal flow of sewage from the present population; and this, when all connections are made, will be conveyed to the outfall works, emptying into a brick chamber situate near to the engine house. At this point all floating matter is arrested and removed, the sewage receiving an addition of milk of lime in the proportion of about five grains to the gallon, and by means of a cast iron baffle causing agitation, the milk of lime is well mixed with the sewage. After passing for a distance of about eighty yards the already partially treated sewage enters another chamber, where crude sulphate of alumina is added in about the same proportion of the lime; agitation again takes place by means of a similar arrangement to that described. From this point the sewage flows to the various tanks—eight in number—which are calculated to contain 450,000 gallons—about 50,000 gallons each. As soon as one tank is filled the sewage is diverted to the next tank, and so on until the sewage in the first tank has been treated and the tank available for a further supply. When each tank is filled the sewage is allowed to remain in a state of quiescence, this being the most effective way for obtaining the best results. The addition of the lime causes the sewage to be rendered alkaline, and so better prepared to received the other reagent. A portion of the added lime forms by its contact with the sewage an insoluble carbonate of lime, and, being insoluble, falls to the bottom of the tank, carrying down with it both suspended matters and also matters in solution. The action of the lime alone with careful manipulation is said to be able to reduce the quantity of organic carbon held in solution very considerably. If found necessary, it might subsequently be desirable to add to the sulphate of alumina protosulphate of iron. The addition of the sulphate of alumina appears by its action to complete the process of precipitation commenced by the lime. In a short time, probably from thirty minutes to two hours, according to the character of the sewage and other conditions, precipitation rapidly commences; the supernatant water rapidly becomes clear, leaving the precipitated matter at the bottom of the tank in the form of sewage sludge.

By means of a novel construction of floating valve the operation of emptying may commence before the precipitation is completed, inasmuch as the valve simply takes the water near to the surface, and is regulated by a sluice valve outside the tanks; the effluent from the sewage thus treated is then conveyed to land twelve acres in extent laid out in level beds as filters, having deep drains constructed on the outside of the beds, underneath the roadway divisions; after passing through the land, the effluent was discharged into the river Tame. By the arrangement described it is improbable that any sewage will pass to the stream unpurified. The sewage sludge deposited in the tanks is taken through pipes communicating directly with the sludge well near the engine-house, and it is proposed that the tank shall be cleansed after each time of using. The buildings erected comprise gas-house, engine-house, sludge pressing-house, lining and alumina-house, workshop, and there is also upon the works a cottage in which the engineer in charge of works—Mr. Wicks—resides. The engine-house contains two 40 indicated horse-power "Otto" gas engines. The engines have direct-acting air compressors for the purpose of lifting sewage by means of Shone's ejectors, four in number, from the low-level to the high-level sewers. There are also operated by the gas engines Westinghouse air compressors and vacuum pump for sludge pressing, driven by belting, as also the lime and alumina mixers, pump fan for forge, lathes, &c. The gas supplied to the engines is known as Dowson's "economic gas," and this is generated in the building near to the engine-house. From experience gained in several districts, this gas is most economical when used in conjunction with the "Otto" gas engines, 1½ lb. of gas coke per indicated horse-power per hour being under ordinary conditions the actual consumption. This compares more favourably with the consumption in high-pressure steam engines, inasmuch as the engines will be required to work intermittently. The gas generators, gas engines, air compressors are in duplicate, so that a complete stoppage through breakdown is extremely improbable. There have been constructed some twenty-seven miles or thereabouts of cast iron or earthenware sewers, varying in diameter from 24in. to 9in., and they have been laid at average depths below the surface of the ground from 7ft. to 27ft. A considerable length of wet subsoil was met with during construction and a consid[illegible]ble quantity of infiltration water was anticipated, but by the use of cast iron pipes and careful jointing of the specially prepared deep socketted earthenware pipes jointed with tar cord and cement, the total quantity of infiltration water does not exceed 5000 gallons in twenty-four hours—about 3½ gallons per minute—whilst on the other hand twenty times this volume could under the circumstances have been defended. This small inflow points to good workmanship and material. Manholes, lamps in inspection shafts, and flushing chambers have been constructed upon the various lines of sewers.

To obviate the necessity of the construction of an expensive low-level sewer over mining ground, Shone's pneumatic system has been adopted with great success, and four of Shone's ejectors have been fixed at the low-level of the town from about one mile to two and a-half miles distant from the air-compressing station. These ejectors are automatic in their action, and seldom require any inspection. The compresssd air is conveyed to them through cast iron mains carefully jointed with lead. The works have been carried out in a workmanlike and satisfactory manner by, No. 1 contract, the Patent Shaft and Axletree Company, for cast iron pipes and special castings; No. 2 contract, the Glenfield Company, Kilmarnock, for gas engines—Otto's—air-compressing machines, machinery sludge, pressing machinery, Dowson's gas plant, and sundries; No. 3 contract, Mr. George Law, of Wednesbury and Kidderminster, for the construction of sewers, outfall, grounds, works, tanks, building, &c. &c. The total amount of loan is £45,000, of which sum £7200 appears for purchase of land, way leave, and incidental expenses. It is not expected that the whole of this £45,000 will be expended. The resident engineer was Mr. C. Richards, of Coventry, acting under the personal direction of the engineer and his assistant, Mr. Fairlie.

Society of Engineers.—The thirty-third annual general meeting of the Society of Engineers was held on December 12th, at the rooms of the Society, 9, Victoria-chambers, S.W. The chair was occupied by Professor Henry Robinson, President. The following were duly elected, by ballot, as the council and officers for the ensuing year, viz.:—As president, Mr. Arthur T. Walmisley; as vice-presidents, Mr. Jonathan R. Baillie, Professor Henry Adams, and Mr. Robert Harris; as ordinary members of council, Messrs. R. W. P. Birch, W. N. Colam, W. Schönheyder, W. A. Valon, C. Anderson, J. H. Cunningham, J. W. Restler, and J. W. Wilson, jun., the four latter being new members of council; as honorary secretary and treasurer, Mr. Alfred Williams; and as auditor, Mr. Alfred Lass. The annual dinner of the Society took place on Wednesday evening at the Guildhall Tavern.

Fog and Smoke.—On the 1st inst. Sir Douglas Galton lectured on the above subject at the Parkes' Museum of Hygiene, when he observed that the greater part of the evil of black fog, which strains our eyesight and lowers our vitality, is preventible, being entirely the result of smoke. Dr. Russell's experiments show that London air during a fog contains four times as much carbonic acid as ordinary air, and that this may be taken as an index of the quantity of other impurities; moreover, some forms of matter, such as ammonia and sulphur, have a greater affinity for the aqueous vapour in the air than other matters. These substances are present in London air to an unnecessary extent, the ammonia arising from manure not removed often enough. Fog is caused by the floating matter in the air attracting to itself the aqueous vapour; and the blackness of London fogs is due to smoke from incompletely-burned coal. Smoke from factories has been largely abated in late years, and might be wholly prevented, as boiler fires may be made smokeless by proper care or mechanical stokers, while bakehouses, potteries, and other furnaces might be made entirely smokeless, as has been practically proved by Messrs. Minton and others. But the chief offenders are domestic fireplaces, as proved by the clearness of London air in the early morning, even in winter, before fires are lighted; and this evil increases daily with the growth of the metropolis, so that, with present experience, it is fearful to contemplate what will be the condition of the atmosphere a few years hence if some radical change in our method of evaporising, rather than consuming, fuel be not adopted. To abolish smoke, the time-honoured but uneconomical open fireplace must be disestablished, and gas used for cooking instead of raw coal. The use of anthracite and so-called smoke-preventing grates being only of avail if the due, but generally neglected, conditions are observed. Our houses must in future be warmed by gas, steam, hot water, or hot air, and must be arranged with this view as they are now for the common fireplaces.

## RAILWAY MATTERS.

AN influential committee has been nominated recently at Tarvin to request the London and North-Western Railway Company to construct a new line from Tattenhall, on the Chester and Shrewsbury line, to Helsby-on-Halton, on the Chester and Manchester line. The line would be eight miles in length, would materially shorten the route for South Wales traffic to Liverpool and Manchester, and would in various ways develope the industries of that part of Cheshire.

As a result of a report on the Abt system of combined rack and adhesion railway for hilly countries, by Mr. Guildford L. Molesworth, consulting engineer to the Indian Government for State Railways, arrangements have been made to convert the whole of the Bolan Railway into a broad-gauge line on the Abt system, and some locomotives and treble track have been ordered by the Indian Government from Messrs. Rinecker, Abt, and Co., of Wurzburg, by the Indian Government.

THE record of train accidents in the United States in October includes 64 collisions, 49 derailments, and 4 other accidents; a total of 117 accidents, in which 34 persons were killed and 109 injured. These accidents are classified by the *Railroad Gazette* as follows:—Collisions: Rear, 35; butting, 28; crossing, 1; total, 64. Derailments: Broken rail, 2; spread rails, 2; defective switch, 5; broken bridge, 1; broken wheel, 2; broken axle, 2; broken brake beam, 2; broken truck, 2; misplaced switch, 5; bad switching, 1; cattle on track, 3; washout, 1; accidental obstruction, 1; malicious obstruction, 1; purposely misplaced switch, 3; unexplained, 16; total, 49. Other accidents: Broken crank pin, 1; broken driving wheel, 1; broken connecting rod, 1; boiler explosion, 1; total, 4. Total number of accidents, 117.

IN a report on the accident that occurred on the 6th October, at Ellesmere station, on the Cambrian Railway, when the train engine ran through the facing points at a speed of 12 to 15 miles an hour, and was pulled up in about 82 yards, and all the vehicles except five at the tail of the train ran off the rails, Col. F. H. Rich says:—"The porter on duty stated that he examined the points after the up train had left, in accordance with the company's rules. If he went from the station to examine the points, which are more than a quarter of a mile east of the station, he must have examined them very carelessly. This man had been on duty about 16½ hours when the up train left Ellesmere station, and 19 hours when the accident happened. After finishing his day duty, he had to take the nightman's duty, as this man was sent to Welshpool. I recommend that all the points and signals at Ellesmere station should be worked from one or two cabins, and properly interlocked. Until this is done, a man should always be near the facing points when a down train is passing to hold the lever by which they are worked, until a proper system of working and interlocking is introduced at Ellesmere station."

TRIALS were made last week at the depôt of the Birmingham Central Tramways Company of various safety apparatus for preventing accidents with tramway engines. One engine was used for testing two contrivances intended to catch persons getting in the way, and carrying them along until the engine can be stopped, while two other guards which were tried have for their object the removal of the person out of the path of the engine. Our Birmingham correspondent writes that the result of the experiments cannot be held to be the discovery of any means of averting the evils of steam street traction. So far the investigations of the Public Works Committee go to show that the remedies are little if any better than the evil they are designed to cure. In the case of every contrivance yet tried, the danger of the framework climbing on to the obstruction and rubbing it along the ground seems to be unavoidable. Two of the appliances—applied to the first engine—were intended to catch persons getting in the way, and carry them along until the engine could be stopped. One was a platform of wooden laths, with revolving india-rubber rollers at the front edge. The other two inventions were intended to remove persons coming in contact with the engine out of its path.

A GENERAL classification of the accidents on the United States railways, in October last, is given by the *Railroad Gazette* as follows:—

| | Collisions. | Derailments. | Other. | Total. | P. c. |
|---|---|---|---|---|---|
| Defects of road | — | 10 | — | 10 | 8 |
| Defects of equipment | 5 | 8 | 4 | 17 | 15 |
| Negligence in operating | 10 | 6 | — | 16 | 14 |
| Unforeseen obstructions | — | 9 | — | 9 | 7 |
| Unexplained | 49 | 16 | — | 65 | 56 |
| Total | 64 | 49 | 4 | 117 | 100 |

The number of trains involved is as follows:—

| | Collisions. | Derailments. | Other. | Total. | P.c. |
|---|---|---|---|---|---|
| Passenger | 21 | 14 | 3 | 38 | 22 |
| Freight and other | 98 | 38 | 1 | 137 | 78 |
| Total | 119 | 52 | 4 | 175 | 100 |

Thus the number of unexplained derailments remains very high, in this case one-third of the whole, and probably will, so long as the attempt is made to run very heavy and long cars on two bogies round curves at high speeds.

WRITING on railway extension to Kurrachee, Mr. Alex. McHinch, chairman of the Kurrachee Chamber of Commerce, at the conclusion of a letter of importance to the *Times*, says:—"Finally, if Government have built a railway system 2577 miles in length, at a cost of 46 millions sterling, would it not be the soundest policy to spend another million or so in completing that system by adding to it a direct line from Delhi to the coast? I cannot, of course, commit myself to any figures in regard to even the probable cost of such an undertaking; but, as I have said, whereas every important line that has been made in India has included most expensive bridges and (or) ghat works, this line has not one until a bridge over the Indus comes to be spoken of, and, in the meantime, the arrangements for ferrying loaded wagons across that river, which have answered so well at Sukkur, would amply suffice. The Sukkur bridge will be finished in the course of some months, and the steamers and barges from that ferry will be available. Then we will be quite content to have second-hand rails, and I submit that to sell 'used rails' to America, as has been and is being largely done, thus enabling cheap commercial lines to be laid in a rival wheat-growing country, while they can be used in India to construct such a short cut as this would be, shows a sad want of foresight."

A BOARD of Trade report by Major Marindin, R.E., on the accident which occurred on October 25th at Chevington station on the North-Eastern Railway has been published. An up express goods train ran into the engine of a special down goods and cattle train. Much damage was done to stock and permanent way, four passengers were slightly and the drivers of the two engines more seriously injured. Major Marindin thinks that the collision was due chiefly to the want of proper care on the part of the driver of the up train, but the responsibility does not rest solely with him, "for there were so many irregularities that it does not speak well for the discipline of the line." After noticing these irregularities in detail, Major Marindin calls attention to another of the chief causes of the collision—the excessively long hours of work of some of the men in fault. The driver of the up train had been at work for thirty-one hours out of thirty-eight and a-half consecutive, and other men had been as long, if not longer, at work. "Such hours of work," says Major Marindin, "should not be tolerated, either in justice to the men themselves or in the interest of the public, for it is quite impossible for drivers, however good they may be, to work for such a time without being worn out, and consequently inattentive and unfit for the performance of their responsible duties."

## NOTES AND MEMORANDA.

OUR attention is drawn to a paper read before the Physical Society, on the 24th February, 1883, by Mr. Philip Braham, F.C.S., on "The Formation of a Solar System," based on gravity and vertical experiments and on spectrum analysis. In this paper are many direct statements and suggestions of exactly the same apparent meaning as the leading data upon which Mr. Norman Lockyer has recently published a long paper, and Mr. Braham claims that in a lecture in December, 1882, and in the paper above mentioned, he has anticipated Mr. Lockyer in all the salient parts of the matter dealt with in the recently published paper.

A GOOD deal is being said just now about a new and what appears to be a good primary battery, as being suitable for mounting isolated lights, namely, Schanschieff's battery. For mining lamps it has claims to adoption, and as a laboratory, but the daily and other papers are speaking of it for lighting purposes generally and especially for trains. None of the writers of these accounts seem to make a few figures for themselves on the subject, or they would see that they have not told very much in its favour for these purposes when they say that the electrolyte costs but "6d. per gallon, and a gallon will keep lights equal to eight candles burning for sixteen hours." This is equal to one 16-candle gas burner for eight hours, which would cost about 1·5d., or equal to one 20-candle incandescent lamp worked by steam for 6·4 hours, costing about 2d.

IN experiments on the electrical conductivity of hot gases, by Mr. J. Buchanan, small pieces of platinum foil are placed vertically and parallel with a flat gas flame between them, the platinum discs being connected with the binding screws of a condenser charged from a Leclanché battery, and with the quadrants of an electrometer; one pair of quadrants being connected to earth. The flame being in action, the battery was disconnected, and scale readings taken at equal intervals of time until zero was nearly reached. From these readings the rate of leakage could be found. Curves are plotted in which the scale readings of the electrometer are the ordinates, and the times the abscissæ, and equations are obtained. It was found that the rate of leakage was more rapid when the insulated quadrant was negatively charged than when positive.

WITHIN the last ten years the introduction of ring frames has gone on with remarkable rapidity in the United States. Most of the new mills that have been built within that time have adopted the ring frame for the spinning of warp yarns, and a number of the older mills have thrown out their warp mules and largely increased their spinning capacity by the substitution of the more modern machine. More recently the mule has been completely abandoned in the spinning department of latest constructed mills, in which both warp and weft yarns are successfully spun on ring frames. The *Fall River Daily News* says the new Flint mill led off in this city in the adoption of this system, but not before its practical utility had been demonstrated at Newburyport, Amesbury, and Lowell. The Seaconnet and Osborn No. 2 have followed suit, and the projected New Sagamore, if built, will spin frame yarns only. Double the number of mule spindles can be operated on the same floor space by the use of frames.

AT a meeting of the Physical Society on the 10th inst. a paper on "The Recalescence of Iron" was read by Mr. H. Tomlinson. If an iron bar which has suffered permanent strain be heated to a white heat and allowed to cool, the brightness at first diminishes and then reglows—recalesces—for a short interval. Under favourable circumstances as many as seven reglows have been observed during one cooling. Generally, two decided ones are observed, one between 500 deg. and 1000 deg. C., and the other below 500 deg. C. The effects, the author believes, are due to "retentiveness" of the material, somewhat similar to the causes of residual magnetism and residual charge of a Leyden jar. Professor Forbes believed the explanation of recalescence given by himself in 1873 is sufficient to account for the effects observed. This explanation postulates a sudden increase in thermal conductivity about the temperature at which recalescence occurs, which permits the heat from the inside to reach the outside more readily, and thus raise the temperature of the surface. The subsequent reglows observed by Mr. Tomlinson he believes due to convection currents of air.

SOME experiments on oxygen in the sun are described by Mr. J. Trowbridge and Mr. C. C. Hutchins. In the experiments, a powerful alternating current was caused to pass between electrodes of aluminium, and the spectrum, obtained by a grating, photographed on one half of a photographic plate, then, without altering the arrangement of the apparatus, sunlight was admitted, and its spectrum photographed on the other half of the plate. The wave lengths of the air or sun spectra were tabulated. The authors point out that in order to be certain of the existence of an element in the sun, the coincidence of a large number of lines of the element in position and grouping with the dark lines of the solar spectrum is necessary, or else a general similarity in the character of the lines; they find no such coincidence for oxygen so far as they have examined (wave lengths 3749·8—5033·85). They find that the bright lines of Draper's spectrum vanish in their high-dispersion apparatus, and contain numerous dark lines, and, moreover, that there is no general coincidence between the oxygen lines and the bright spaces of the solar spectrum. The authors find that the solar spectrum near H contains dark lines exactly agreeing with the spaces between the bright lines of the flutings of the carbon spectrum. The carbon spectrum is wanting in the green and blue. This may be due to the effect of vapour in the sun's atmosphere, the lines due to any element being unaltered, obliterated, or reserved, according to the temperature of the vapour through which the light passes. The fluted carbon spectrum of the voltaic arc is due to a reversal of the continuous spectrum of the ignited carbon by its own vapour; hence the temperature of the sun's atmosphere where the carbon is volatilised must approximate to that of the voltaic arc.

AT a recent meeting of the Physical Society a paper was read on "The Analogies of Influence Machines and Dynamos," by Professor S. P. Thompson, D.Sc. The author pointed out that in nearly all influence machines there are two stationary parts—inductors—electrified oppositely, which are analogous to the field magnets of dynamos, and a revolving part carrying sectors, which correspond to the sections of an armature. In the Wimshurst machine both field plates and armature rotate, and each act as field plate and armature alternately. In the two field plate influence machines there are four and sometimes six brushes. Two of these act as potential equalisers, two as field plate exciters, and the remaining two (if any) are generally placed in the discharge or external circuit. The Holtz machine, having only four brushes, two serve the double purpose of potential equalisers and discharge circuit, and this machine excites itself best when the discharging rods are in contact. In this respect it resembles a series dynamo, which only excites itself when the external circuit is closed, but on opening the circuit—say by inserting an arc lamp—produces remarkable effects. So in the Holtz machine, on separating the discharging knobs, a shower of sparks result. The Toepler machine, made by Voss, having six brushes, resembles a shunt dynamo, and excites itself best on open external circuit. Analogies were traced between Thomson's replenisher and the Griscon motor. Armatures of influence machines, as in dynamos, can be divided into ring, drum, disc, and pole armatures, and examples of each kind were mentioned. The Clark gas lighter is a good example of a drum armature, and a diagram showing the internal arrangements was exhibited. An example of an analogue to the compound dynamo was mentioned as existing at Cambridge, in the form of a Holtz machine, believed to have been modified by Clerk Maxwell. Another analogue with dynamos is found in the displacement of the electric field when the armature is rotated, just as the magnetic field of a dynamo is shifted round in the direction of rotation.

## MISCELLANEA.

MESSRS. FLEMING AND FERGUSON, Paisley, have this week received orders to build a steel screw steamer of 1000 tons for the Eastern trade. She is to be fitted with quadruple expansion engines by the builders.

A NOVEL application of the blower from the Merthyr Vale Colliery has just been made; it has proved a splended illuminant for months. Now it has been adroitly brought under three of the boilers, to the saving of nearly 100 tons of small coal per week. This is turning a dangerous enemy of the colliers to good account.

FOR supplying air to lift the sewage of South Lowestoft on Shone's pneumatic ejector system, the British Gas Engine Company is supplying three 4-horse power gas engines, with combined compressors. The compressors are the same as those at the Houses of Parliament as illustrated in our pages, but the engines are of Atkinson's cycle type.

THERE is now open at the Society of Arts, John-street, Adelphi, an exhibition consisting of a collection of art work sent in in competition for the Society's prize. The collection will remain on view until the 23rd inst., and comprises painted glass, glass-blowing work in the Venetian style, inlays in wood, decorative painting on wood, metals, and other materials, hand-tooled bookbinding, and repousse and chased work.

AFTER prolonged trials at the International Exhibition of Turin last October, and recommenced at Milan in November, Messrs. Shand, Mason, and Co., of London, in competition with Swedish, Belgian, and French makers, have received the highest commendation, disposing of the pump exhibited to the city of Milan, which, curious to relate, is the first steam fire-engine this city possesses, notwithstanding its commercial importance a population numbering over 400,000 inhabitants.

THE Bradford Town Council determined on Tuesday to carry out a scheme for supplying electric light to the public buildings and to those firms in the business part of the town who require the light. The present expenditure for that purpose is limited to £15,000, and it is estimated that the cost to the private consumer will be just double the cost of gas. The electric cables will be laid underground. The Corporation some time ago secured the monopoly of the electric light supply.

THE Committee of Lloyd's "Register" have just issued circulars stating that they now sanction the use of basic steel of $\frac{8}{16}$in. in thickness and under for shipbuilding and boiler making purposes carried out under their supervision, provided that the works supplying such material first satisfy them that they are producing it in accordance with their tests, and of a uniform quality. The Glasgow Iron Company, of Wishaw, near Glasgow, are now making and supplying steel under these conditions.

WHAT is practically the closing scene in connection with the Manchester Exhibition has been enacted this week by the sale of the buildings, fittings, and loose materials. Some portions, such as Old Manchester and Salford, and the grand approach through the Botanical Gardens, have at the last moment been reserved, but with these exceptions the entire structure has been put up to auction. The committee had placed a reserve of £9500 on the buildings, but as they did not get a higher bid than £9250, they were put up and sold in separate lots.

AN inkstand of interest to draughtsmen is being made by Messrs. Bemrose and Sons, Derby. It is made for containing liquid Indian ink, and is so constructed that so long as it contains a supply a slight pressure upon a nozzle into which the pen is dipped causes the ink to be lifted from the reservoir to the pen through a hole, which is so small as to prevent the access of dust or any material evaporation. No ink is spilled if the stand is upset. It occupies a small space, and may stand on the drawing-board within easy reach of the hand.

A SERIES of articles on the marine engineering of the Victorian era is now being published in pamphlet form at the *Shipping World* office. The pamphlet is interesting as a general survey of the changes of the period, and nothing is perhaps more remarkable than the great changes in the construction of marine boilers. The sketches and references to some of the old square box boilers remind one of forgotten times, when low pressures, salt water and cold water were universally used, and form a very great contrast to the modern circular boiler, very high pressures, fresh water feed, generally at high temperature, or always at high temperature, where economy and the life of the boilers are most considered.

MR. EDWARD WESTON, the electrician, as quoted by the *U.S. Army and Navy Journal*, says:—"It is well known that the nitrate of amyl possesses the power of causing insensibility very quickly in a human being breathing its fumes. The effect is equivalent temporarily to a paralytic stroke. Now, nitrate of amyl is very cheap and plentiful. I propose to fire shells filled with this chemical instead of gunpowder. It will not be necessary to penetrate a ship. A few gallons of this nitrate dashed on the deck of a warship would soon render her crew helpless. The most powerful ironclads would be even more vulnerable than the light cruisers, for they would be sucking down great draughts of air through their artificial ventilators, and the odour would thus rapidly permeate the whole ship. The whole crew being rendered helpless for an hour or two, the ship could, of course, be towed into a safe spot, while the captors ventilated her and removed the insensible men."

FROM recent reports it appears that the number of German workpeople increased in the fifteen districts for which the reports are published from 596,561, in 1884, to 642,386, being an increase of 33,496, or 7·7 per cent., of males, and 12,329, 7·6 per cent., of females. The industries in which the chief increase took place were textiles, food, wood, and carving. There was a great decrease in the number employed in mining. In some districts there was a great lack of employment, while farmers were complaining that they could not find labourers to do their work. In Bavaria, in 29·4 per cent. of all industries, the hours of labour were from 11¼ to 16 hours daily; in 59·6 per cent. from 10 to 11 hours; and in the remainder from 11 down to five hours. The last-named time applied only to the work of putting the quicksilver on the backs of looking-glasses. Excessively long hours prevail in breweries, where they are never less than sixteen hours a day. In the Dusseldorf district nearly forty manufacturers of textiles have agreed to keep the working-day within twelve hours.

THE New York correspondent of the *Standard* says:—"A huge lumber craft is now on its way to New York from Nova Scotia, which, if it arrives safely, promises to effect a radical change in the method of shipping lumber from Canadian ports. This raft consists of twenty-seven thousand trees, bound together by a series of chains, which connect those around the outer edges with a larger central chain, running lengthwise along the mass. The shape of the raft resembles that of a cigar. Its length is 560ft.; its greatest diameter 65ft. It thus exceeds in dimensions the Great Eastern steamship, and it is twice (*sic*) as heavy as that vessel, the weight of the raft being 11,000 tons. The total cost of the raft, including timber, construction, and transportation, is about 30,000 dols. The raft has the capacity of seventy large schooners, and the freight charges alone for this amount of timber are 25,000 dols. Two other rafts of the same size are now being built in Nova Scotia. It will be taken through Long Island Sound and Hell Gate, instead of by the longer route round Sandy Hook and through the Narrows." We need hardly say that the Great Eastern is 690ft. in length on deck. Her weight to load line is double that of the raft, or 22,000 tons, and 10,000 tons of plates were used in her construction.

# COMPETITIVE DESIGNS FOR A NEW BRIDGE AT MANNHEIM.

*(For description see page 489.)*

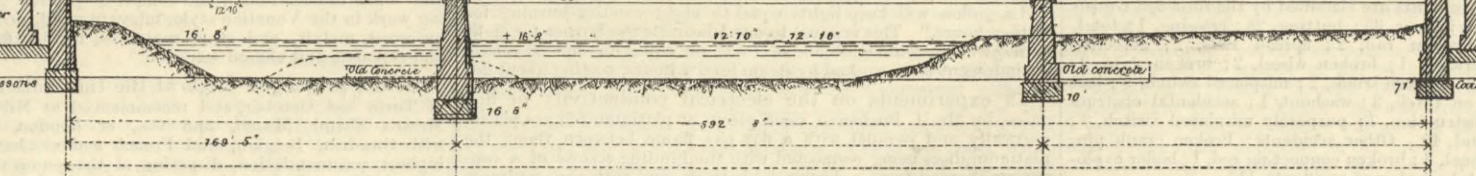



Fig 1 First Prize Project of Benckiser Brother Pforzheim, A. Bernatz, Grün and W. Manchot, Mannheim.

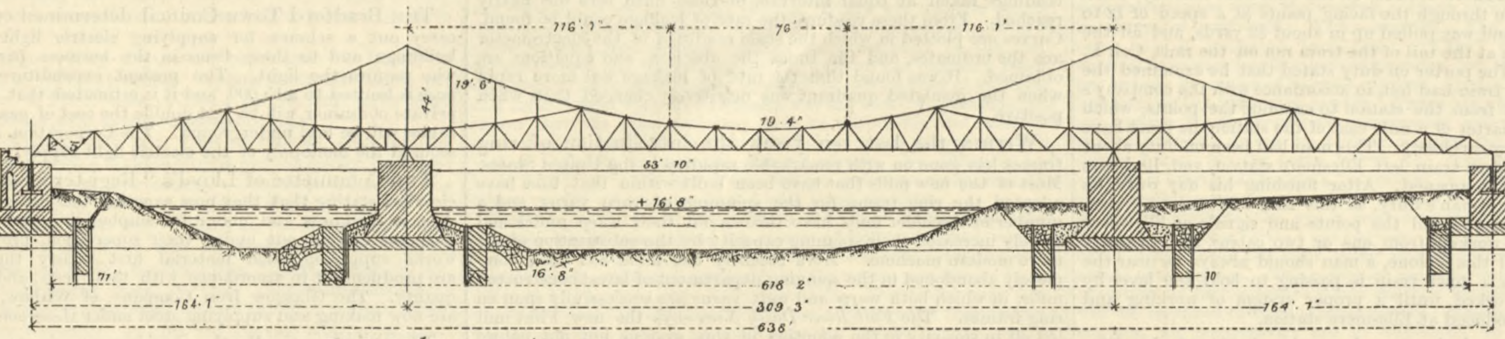


Fig 2. 2nd Prize. Project of H. Gerber, Fr. Thaersch, E. Bailet, München and A. Ruppel in Gustavsburg.

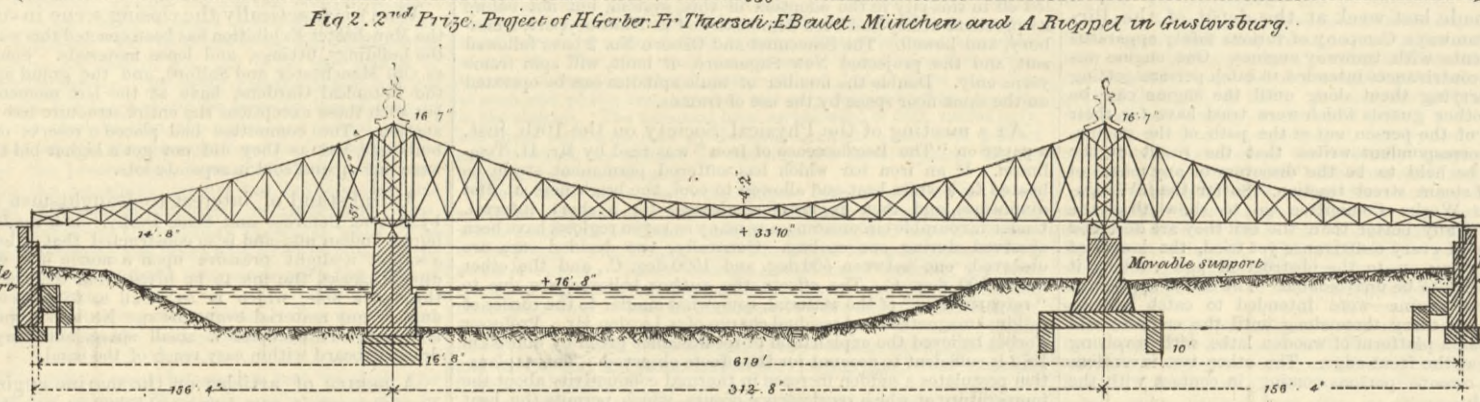



Fig 3. 3rd Prize Project of W. H. Lauter Frankfurt on Main and Dr. J. Durm, Karlsruhe.

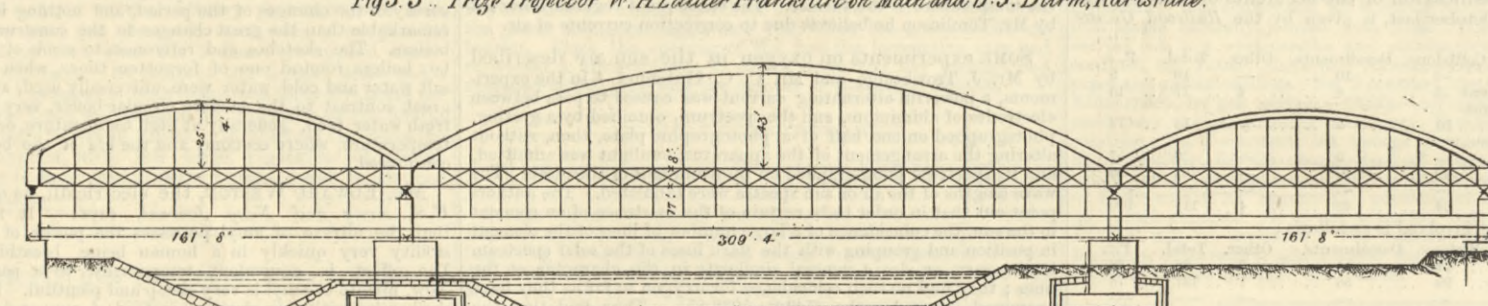


Fig. 4. Project of Messrs. Möller, Schmidt & Eckert, Hamburg.
(Scale 1/1000)

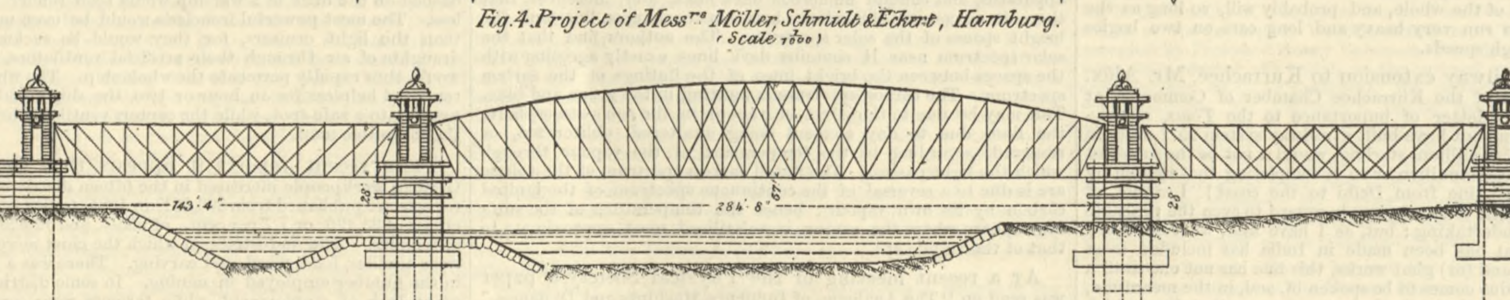


Fig. 5 Project of Otto Klett, Canstatt & Mr. Beisbarth, Stuttgart.
(Scale 1/1000)

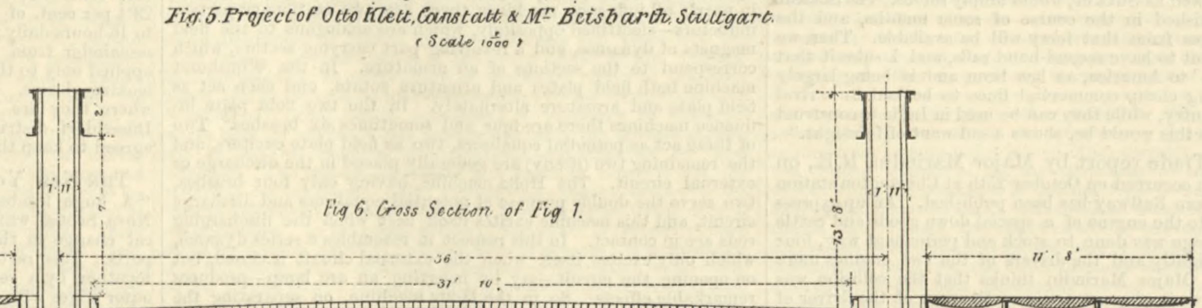
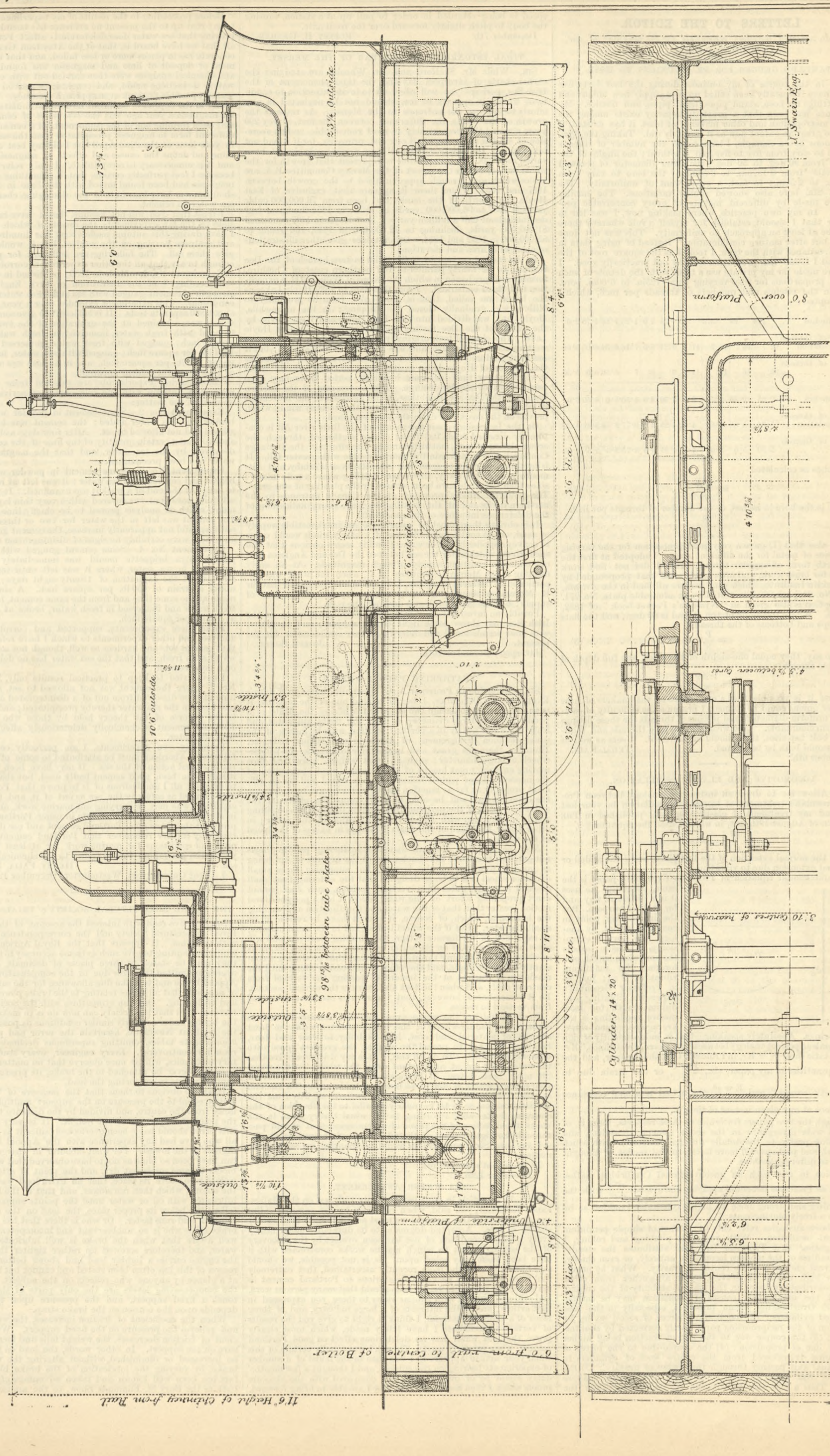



Fig 6. Cross Section of Fig 1.

Project of Benckiser Bernatz & Grün, and Manchot.




TEN-WHEELED TANK LOCOMOTIVE, CHINA RAILWAYS.

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

(For description see page 410 ante.)

## LETTERS TO THE EDITOR.

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

### STANDARD GAUGES FOR BRASS UNIONS TO HOSE.

SIR,—In the course of my business during the last forty-five years I have frequently been called upon to supply new unions and other fittings for hose, stand pipes, hand pipes, and nozzles. My experience has been that a great discrepancy exists among the various metropolitan and other makers; at least, it has existed, if not to so great an extent now as it formerly did. Taking the 2½in. bore unions as an example, I have found the number of threads per inch to vary from five to five and one-third; the angles of the threads from 90 deg. to 50 deg.; the outer diameter of screwed part—male—from 3·1875in. to 3·5625in.; the bore to vary from 2·3125in. to 2·50in.; in fact, a great want of uniformity. The reputed 2in. bore also showed similar variations. The smaller sizes are made by different makers of every conceivable proportion. In my own practice, where making new, I was led to consider that I should establish for myself a rule whereby there should be at least an approach to uniformity. This was not done hastily, but after mature consideration. Instead of using data in strict accordance with the bore, I took it as the square root of the bore, and I found the proportion worked out practically good. I therefore made for my private use a table with the details of such relative proportions for sizes varying from ·125in. to 6·00in. bore. I subjoin the pitches and numbers of threads per inch, which I have adopted :—

| Bore in inches .. | ·125 | ·25 | ·375 | ·50 | ·75 | 1 0 | 1·25 | 1·50 | 1·75 | 2·0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of threads by calculation . | 22·7 | 16 | 13·2 | 11·3 | 9·24 | 8·0 | 7·16 | 6·54 | 6·05 | 5·66 |
| Number of threads used .. .. .. | 23· | 16 | 13· | 11 | 9· | 8· | 7 | 6·50 | 6·0 | 5·50 |

| Bore in inches .. | 2·25 | 2·50 | 2·75 | 3·0 | 3·50 | 4·0 | 4·50 | 5·0 | 5·50 | 6·0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of threads by calculation .. | 5·34 | 5·06 | 4·83 | 4·62 | 4·28 | 4 0 | 3·77 | 3·58 | 3·42 | 3·266 |
| Number of threads used .. .. .. | 5·50 | 5·0 | 5·0 | 4·5 | 4·25 | 4·0 | 3·75 | 3·5 | 3·5 | 3·25 |

The pitches as calculated

$$= \frac{\sqrt{A}}{8}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where A is the bore in inches, or the number of threads per inch

$$= \frac{8}{\sqrt{A}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

I found also that (1) gave a very good proportion for the varying thicknesses of metal for the different sizes. I adopted at first the Whitworth form of angular thread. This I did not find work out well for brass work, and afterwards used that propounded by the Franklin Institute, which your readers will find in the *Artisan*, vol. ii., No. 24, page 269, illustrated by an admirable plate, No. 271. A description is also given in "Nystrom's Pocket-book" of 1882, page 293. Where the angle of the thread is 60 deg., and the flats at the tops and bottoms of the threads

$$= \frac{P}{8}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

that is to say, they equal one-eighth of the pitch, the full depth of the double thread

$$= \frac{1 \cdot 299}{N}. \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Suppose it is possible that a conference of the makers of hose and other unions could be formed, I presume the difficulty of establishing uniform diameters and pitches of threads for these fittings is not insurmountable. Like wrought iron pipe threads and Whitworth's bolt tap sizes, they should be universal. Users as well as makers would both be benefitted. TUBAL-KAIN.

December 6th.

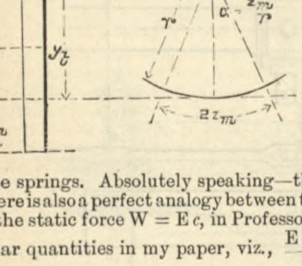
### LOCOMOTIVE AND ELASTIC OSCILLATION.

SIR,—Allow me to draw an instructive analogy between Professor Greenhill's treatment of locomotive oscillation in your last issue, and my treatment of elastic vibration, published in THE ENGINEER of August 19th last, in which I used the equation § 5,

$$y_t \frac{d^2 z}{d t^2} = - g z,$$

$y_t$ being the normal extension of the test piece, and $z$ the added or subtracted extension due to vibration.

The fundamental equation of Professor Greenhill's paper is the same, although he uses it in a different way and for another purpose. But the interesting point in common is that, by analogy, the normal extension $y_t$ in elastic tests is the pendulum length performing the maximum vibration, $2 z_m$; just as in Professor Greenhill's papers the vibrating pendulum length for locomotive oscillating is the average permanent set, $c$, of the springs. Absolutely speaking—that is, independently of sign—there is also a perfect analogy between the "force of resistance," E$x$, and the static force W = E$c$, in Professor Greenhill's paper, and the similar quantities in my paper, viz., $\frac{E \varpi z}{l}$, or the strain due to the "elastic excess," and $\frac{E \varpi y^1}{l}$, the actual tensional resistance in the piece at any given instant of time.




Although the two papers fraternise in these respects, there is, of course, a wide divergence in the scope, general treatment, and results, due partly to the totally different materials with which they deal, and perhaps still more to the special modes of thought peculiar to different authors.

I rejoice to find such an unconventional Cambridge mathematician as Professor Greenhill applying the symbol $\frac{d^2 y}{d t^2}$ with the same facility and strong faith to highly constrained motion as he would to a freely moving mass.

The above analogies refer only to the case of simple pendulum in vertical oscillation. With regard to pitching and rolling, I do not gather that Professor Greenhill attributes the steadygoing qualities of the modern locomotive entirely, or even chiefly, to the great elevation of its centre of gravity. What he proves is that a high centre of gravity, apart altogether from other causes, contributes a share to the general stability of the engine. Amongst the many other causes of oscillation may be enumerated—(1) Overhanging steam pressures, especially in the case of inclined cylinders; (2) longitudinal forces of recoil set up by the motion of the reciprocating parts, partly corrected by counterweights; (3) the couple due to the line of traction being higher than the line of propulsion; (4) the couple due to the forces of recoil being transferred from the centre lines of cylinders to longitudinal axis passing through the centre of gravity; (5) the motion of the water in the boiler when the engine changes speed. Thus a flow sets in towards the smoke-box when the speed is being retarded in order to pull up at a station, causing the body to pitch slightly forward over the front axle.

December 7th. ROBERT H. GRAHAM.

### TIDAL ESTUARIES AND THE BAR OF THE MERSEY.

SIR,—While Mr. Shelford and Mr. Wheeler are studying the earlier charts of Liverpool Bay and the tidal phenomena of the Irish Sea, perhaps you will allow me to invite attention to conditions which, it appears to me, should not be neglected in any efforts to improve the entrance to the Mersey. As respects the growth of the banks, the difference between the first survey 200 years ago and the present day is most remarkable, and an accretion of sand is the cause of all our woe, primarily, for if it had not taken place, the access to the Mersey would probably not have varied as it has. It is impossible to represent that growth for the whole period, but in the report of the Mersey Committee B.A. are tables which give a rough approximation to the growth between 1837 and 1854. From them it appears that, exclusive of East Hoyle, the growth of the banks had been from 76,000,000 cubic yards in 1837 to 96,000,000 yards in 1852; in 1854 the latter had declined about half a million yards. East Hoyle in 1837 contained 81,000,000 yards, declining to 72,000,000 in 1846, and rising to 85,000,000 in 1852 and 1854. Other tables give other illustrations of changes in area and elevation.

In the earliest survey, by Collins, the eastern branch of the Dee is shown to be nearly parallel to the northern coast of Cheshire, forming a secure haven in which the troops of William III.'s expedition to Ireland embarked. From that date to 1839 Hoyle Lake, as the haven was called, that is, Isle Lake, from its proximity to Hilbre, was gradually closed to shipping; in the meanwhile, Hoyle bank was divided into two, East Hoyle and West Hoyle, by the waters of the Dee forcing another passage in lieu of Hoyle Lake. This channel took originally a direct course, parallel to the western coast of Cheshire, and was known as Hilbre swatch; but it has kept gradually trending to the eastward, and now approaches the position of Hoyle Lake as it appears on Collins' chart. Thus it would appear that for some indefinite period there may have been cycles of similar change. The movements of the eastern branch of the Dee are, doubtless, to be ascribed to the movement of sand principally under the influence of the westerly winds, which prevail on the coast and drive the sand eastward.

On the Lancashire coast the mouth of the little river Alt is continually diverted from its direct course southward, through the accumulation of sand, notwithstanding the efforts of the Drainage Commissioners to maintain the shorter course with greater fall. It is by this same drift of sand the inhabitants of Formby and Altmouth were driven away, the former settling above a mile inland; since then the sands have been secured by the planting of star-grass. The powerful sluices provided at the Canada entrance to the northern docks and at the landing stage are strong indications of the deleterious influence of the sand-drift.

It is obvious there must be somewhere an inexhaustible supply of sand, or the continuous influence of westerly winds would cease to convey supplies by air or water; and it seems obvious that the small rivers which enter the sea between the Dee and Anglesea cannot maintain constant supply of such magnitude. At an early meeting of the Mersey Committee B.A., when the work was apportioned to different members, Lord Harrowby suggested that Sir R. Murchison should undertake an inquiry into the source of supply; but the great geologist declined the task.

Possibly an investigation of some of the tidal phenomena of the Irish Sea may throw some light on the subject; and, therefore, with your permission, I will defer its further consideration for the present. JOSEPH BOULT.

Liverpool, December 10th.

### FEATHERING PADDLE-WHEELS.

SIR,—Referring to Professor A. G. Greenhill's letter in Friday's ENGINEER, 9th December, I beg to remind him of the fact that it is an easy matter to design the gear for feathering the floats of a paddle-wheel of large diameter, so that the floats will enter and leave the water nearly in a vertical position, and by means of the usual common arrangement of excentric and radius rods, &c. However, there are great and insuperable drawbacks to paddle-wheels of large diameter; such as great weight, heavy and slow moving engines, great height of shaft, great wind obstruction of the necessary large paddle-boxes. Such a wheel will be an efficient propeller as far as reaction on the water is concerned, because the entering float will be able to exert propelling effort on the water by reason of the peripheriferal motion of the float coinciding nearly in direction with the horizontal motion of the water; in other words, the speed of the floats is always in excess of the speed of the water.

Now the adoption of small diameter feathering paddle-wheels mitigates all the above drawbacks, but at the expense of not being as good a propeller as the larger. For supposing for a small diameter wheel it is to be so designed that the entering float shall descend into the water in a vertical position, such float cannot exert propelling effort on the water unless it has a peripheriferal motion greater than that of the water and the direction approaching the horizontal, which, of course, it cannot have by reason of its small diameter. But if the wheel is designed in the usual manner, as explained in my former letter, the entering float can and will exert propelling effort on the water by means of the float acting as an oblique plane passing through the water, thus producing a constantly-changing angle, and therefore an increasing effort, until the maximum is reached at the instant of passing the vertical from centre of shaft, and when the float also assumes the vertical position. Be it remembered, however, that the reverse conditions obtained from vertical to recess.

Sir, I should say the whole grand problem consists of how to construct a paddle-wheel of the least diameter with the least amount of material and cost, least liability to wear and tear, breakage, &c., but to propel the ship at the greatest speed with economy as to fuel. To do all this, I dare say it is imperative that the water must not at any instant drive the wheel, nor the wheel lift much back water. If Professor Greenhill will kindly favour your readers with a sketch as to how he would accomplish the end so that "the entering floats must be inclined slightly from the vertical position, so as to be nearly parallel to the direction of the emerging floats—and, according to the usual theory given in the books, the direction of the plane of an emerging float should pass through the highest point of the pitch circle of the paddle-wheel," —I am sure, Sir, your readers would be thankful for such information. R. HARTLAND.

19, Merchant's Quay, Cork,
December 12th.

### SEA WATER AND CEMENT.

SIR,—In an article in your issue of July 15th last on the Maligakanda Reservoir, you said, when referring to the cement: "But our confidence in this material we must admit to have been rudely shaken of late. Accepted dogma as to its durability under nearly every possible condition of use has been overset by the discovery of the serious extent to which marine works constructed with it have been chemically acted upon. Is is not possible, we should say, having in view the facts recently ascertained, that extremely foul fresh water may prove as deleterious to Portland cement as sea water has proved to be." I am afraid that many persons were, and still are, imbued with similar views to those you expressed in that article; and in the interests of a large industry, and of those users of a valuable material, I think it right to give you the results of certain experiments I have lately made, which most clearly prove that sea water has no deleterious effect on good Portland cement, when properly used. Though I was equally certain of this when your article appeared, I was then in the midst of a number of experiments bearing on the subject, and I thought a few months' delay would be of little importance compared with the absolute proofs which I then hoped and now find I am able to bring forward.

Before proceeding to the results of my experiments I should like to say that up to the present no evidence has been brought forward proving that sea water does deleteriously affect Portland cement; all that we have heard is, that at the Aberdeen Graving Dock the concrete has in places more or less failed, and that in parts a sediment or deposit of lime and magnesia was found. Experiments and chemical analyses were then carried out with cement and sea water, deductions made, and conclusions arrived at, which it is scarcely possible to think even approach accuracy. Magnesia being found in the deposit or sediment no doubt stimulated investigation, for magnesia a year ago was the *bête noire* of cement users; but magnesia forming one of the components of a cement is in a very different form to magnesia precipitated from the sea. In an article in your issue of the 22nd April last I did my best clearly to determine and define the causes and effects of magnesia in a cement, and it is unnecessary to recapitulate. I only refer to the matter, because I feel perfectly certain that if something else instead of magnesia had been found mixed with the lime in the deposit, we should never have heard about the damaging chemical effects of sea water on cement.

I trust that you will not assume that I have based my conclusions on the few experiments, the results of which are here given. I have during this autumn made about one hundred experiments and analyses bearing on the subject, but it would be useless to give them all. The following are sufficient for proof, and it is enough to say that all the other experiments corroborated these.

Experiment No. 1.—Made in 1880; published in the Minutes of "Proceedings" of the Institution of Civil Engineers. Tensile strength of cement gauged with sea and fresh water under varying conditions. This experiment extended over a year, and comprised about 800 separate tests. It is sufficient to give some of the results which were obtained at the expiration of the twelve months:—Gauged with fresh water, immersed in fresh water, 840 lb. per square inch; gauged with fresh water immersed in sea water, 1064 lb. per square inch; gauged with sea water, immersed in sea water, 835 lb. per square inch, and in no case was any degradation or blowing of the cement apparent.

The following experiments are selected from amongst those made this autumn with the sole object of arriving at a decided opinion on the matter:—

Experiment No. 2.—Some cement in powder was placed in a beaker and sea water added; the cement was kept continually stirred and not allowed to set. After four days a chemical analysis showed that a certain quantity of the lime of the cement had been dissolved by the sea water, and that the magnesia in the sea water had been precipitated.

Experiment No. 3.—Some cement in powder was placed in a beaker and covered with sea water; it was left at rest and allowed to set. At the end of a week it was examined. It was found to be set quite hard, but was covered with a very thin layer of soft sediment, which on analysis proved to be chiefly lime and magnesia. The cement was left in the water for two or three months. The sediment did not apparently increase, the cement got much harder, and there were certainly no signs of disintegration or blowing.

Experiment No. 4.—Some cement gauged with sea water and placed in a briquette mould was immediately after gauging immersed in sea water, where it was left until tested for tensile strength at the expiration of twenty-eight days; it then broke under a strain of 650 lb. per square inch. A similar briquette, made at the same time and from the same cement, but gauged with fresh water and immersed in fresh water, broke at the same date at 540 lb. per square inch.

From these experiments, supported and corroborated by the analyses and other experiments to which I have referred, I deduce that cement sets and hardens as well, though not so quickly, in sea water as in fresh, and that the sea water has no deleterious action on a good cement.

I have tried to keep to practical results only, but experiment No. 2, where the cement was not allowed to set, shows that the lime may be dissolved from out of a disintegrated cement, and the magnesia in the sea water thereby precipitated; and this, I believe, is the reverse of the theory held by those who maintain that Portland cement is chemically deleteriously affected by contact with sea water.

From my own experiments, I am perfectly certain that the failures at Aberdeen must be attributed to some other cause than the chemical action of the sea. It may have been bad cement, or it may have been good cement badly used, but that I do not wish to discuss; all I am desirous of is to prove that Portland cement may be used as safely in the sea as out of it, and to assure those engineers who may be carrying out marine work, and who may be in doubt, that they are quite safe in using Portland cement, *i.e.*, provided they have good Portland cement and use it properly; and they may further remember that Portland cement has been used under all conditions for marine work for at least the last thirty years, and no failure can be traced to the chemical action of the sea. HENRY FAIJA, M. Inst. C.E.

4, Great Queen-street, Westminster, December 12th.

### THE ROYAL AGRICULTURAL SOCIETY'S TRIALS OF BRAKES.

SIR,—I have read with interest the account of the trials of the Royal Agricultural Society and the correspondence in connection with the same. It appears that the Royal Agricultural Society, whilst attempting to give such extreme accuracy to their trials that they may be stated to three places of decimals, have by some oversight omitted the error due to the compensating levers of the Appold brake and to make due allowance for the same. It follows of necessity that all tables relating to the brake power are erroneous and misleading. One can sympathise with the Society in this misfortune. All that the Society can now do is to make fresh trials of the brakes under as nearly similar conditions as possible to those of the trials at Newcastle, ascertain the error and publish correct approximate tables, omitting superfluous decimals. There is no room for controversy. Every engineer, every student in elementary mechanics, will at once observe that no matter how the compensating lever be attached to the brake, its pressure on the fixed support assists in supporting the load.

It will be obvious to them that the measure of that assistance will be equal to the pressure on the support multiplied by its distance from the centre, and divided by the distance to the centre of the point of suspension of the weight. It is very surprising that this error should have been overlooked, since it is well known to all who have had any experience with the Appold brake from the highest to the lowest. For what labourer in charge at the brake can have been so blind as not to have observed that when the brake-blocks became somewhat dry, and the point of attachment to the weight rose above its place, that an extra load was thrown upon the engine, which then ran slower, and that if the brake was then lubricated with oil or water until the points supporting the load fell a little below its proper place, the load on the engine is then relieved, and runs faster. Or who is there that has had charge of brake trials who is so unobservant and incompetent as not to be well aware that when the brake is well lubricated with oil and water, and therefore screwed up rather tighter than usual, that the engine carries a lighter load and shows better results. The reason of this has often been stated and cannot but be perceived at at a glance by anyone who reflects on the subject. The ends of the compensating levers are the only parts of the brake which touch a fixed support, and the pressure upon them obviously depends upon the tension on the brake strap.

When the coefficient of friction increases, the weight is lifted, and relieves the pressure on the fixed support. When the coefficient of friction decreases, the weight falls and increases the pressure on the support. In other words, the load on the engine can be increased or diminished, without altering the weight on the brake, by varying the lubrication of the brake blocks; and this fact has been well known and taken advantage of, at least as far back as the Bury St. Edmunds Show, to the amusement of those who were in this open secret. No one will blame the experienced exhibitor who returns his smudge and well waters his brake. It is rather unfortunate that a letter intended to be in the defence of the Society should appear under the signature of "R. A. S., Westminster." In the latter part of his letter the writer states a proposition which he thinks indisputable, but which is obviously untrue if the word "tend" be used in the same sense as he afterwards uses it. The writer seems half-conscious that he is in a fog somewhere. Your readers will have perceived with amusement that it is not in Mr. Druitt Halpin's letter that the mare's nest is to be found. The brake constructed by Messrs. McLaren, in imitation of that of the Royal Agricultural Society, seems to have been far more inaccurate; but with the correction made by Professor Barr, its indications must be correct, as also must have been those of Mr. Halpin's brake.

Messrs. McLaren's contention, if I understand it, is this—that all the competing engines have been credited with more power than they have really driven, and are therefore incorrect. This cannot be denied, and no amount of correspondence can alter the fact. They have a grievance which they have the good taste not to state, viz., that the prize engine, having driven a brake fully lubricated, drove a less proportion of the apparent load than their engine drove, so that if the proper corrections had been made they would have stood in the first plase. This injustice—assuming it is so—can only be partially remedied when the Society publish their amended tables. Messrs. Ransomes and Sims have, I believe, long used a brake in which the error due to the compensating levers can be measured, viz., Mr. Balk's dynamometer, which received a favourable report from the judges and stewards of the Royal Agricultural Society at the Lincoln Show, and was placed at their service by Messrs. Ransomes and Sims at the Bury St. Edmunds Show, when the Society's large brake failed to work properly. Messrs. McLaren also contend that the Royal Agricultural Society do not act rightly in giving prizes solely from the economy of fuel attained, without regard to the general fitness of the engine for the purpose for which it is constructed. In this I fully concur, with perhaps a little personal feeling. I can but remember the trials at Cardiff. The engine which received the prize was, in my opinion, utterly unsuitable for a portable engine, and its makers, I believe, have never reproduced it, whereas the engine which I designed was adopted by the makers as their standard commercial engine.

In reference to placing water inside the brake wheel, speaking from memory, I believe I had this applied to Messrs. Ruston, Proctor, and Co.'s engine in 1868, to make the trials with the heavier load for the Bury St. Edmunds Show.

In 1872 I applied it to the Appold brake of Messrs. E. R. and F. Turner, and all the trials of the Cardiff Show were thus made. The brake ran about four hours at a stretch with about 25-horse power, and I noticed that although clouds of steam were produced, the temperature of the water remained very constant, and never reached 110 deg.

It is a great convenience to keep the brake at a uniform comparatively low temperature, to do away with the splashing, oiling, and dirt, and to run the brake almost without lubrication.

Wilson Hartnell.

Benson's-buildings, Park-row, Leeds, December 13th.

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Sir,—We are very pleased to see that our last letter has called forth so much attention from your correspondents. This brake question requires thoroughly thrashing out, and the errors explaining, but it is evident that "R. A. S." has not thrown much light on the subject.

Before replying to the various letters, we may say that we wish it to be thoroughly understood that we are not trying to prove our engines did better at Newcastle than they got credit for; in fact, we intend to prove that none of the engines tested at Newcastle got the economy they were credited with, and this applies more or less to all engines tried at Cardiff and elsewhere on the brakes of the R.A.S.E. Those who can read between the lines—like "R. A. S."—may now get a notion where a considerable portion of the supposed economy springs from in engines tested by the R.A.S.E. We have no doubt that these engines have been greatly indebted to the R.A.S.E brakes, and their method of working them. We also wish it to be clearly understood that we do not pretend to give the amount of error in the R.A.S.E. brakes; but there is an error, and it is not by any means a small one, which becomes of great importance when the results have to be worked out to the second place of decimals. The error we speak of is common to all brakes fitted with Appold compensating levers, where the brake blocks are lubricated with water run on outside of rim, as was done at Newcastle, and the forces acting on the inner ends of the compensating levers are neglected.

We have proved by our own brake—which you have illustrated—that this error may amount to as much as 56 per cent.

"R. A. S." states that the only difference we managed to make between the Halpin correct brake and our own Appold brake was ·03 lb. of coal per horse-power per hour. He remarks, surely this is a great cry and little wool. "R. A. S." had better look again at the results of our two tests, and he will see that this 0·3 lb. is the difference remaining after the error in the brake had been allowed for, which proves conclusively that we managed to measure the error very correctly. Had we neglected this error, as was done at Newcastle, there would have been a difference of 56 per cent. between the results on the two brakes. "R. A. S." remarks that it is evident to him that Mr. Halpin and Professor Barr have not told the whole truth, and that they must have made more than two tests, and selected those sent to you for publication. Here he is wrong again. Messrs. Halpin and Barr only made the two tests, viz., those published. Neither of these gentlemen have been present at any other tests conducted by us or for us.

"R. A. S." gives a few reasons for his assumptions; first, he says is it likely that we would go to the expense of a new brake, and then only make two tests? In reply to this we may say that as a rule we use lower paid labour in our testing shed; other tests may have been made, but not by Professor Barr and Mr. Halpin. Now, this expense argument is not a bad one, but seeing that we had already gone to so much expense in going to Newcastle, and had not got at the truth, we thought we might as well go to a little further expense, and make two correct brakes and get at the truth. These same reasons prompted us to get a Moscrop recorder. Both were suggested by Mr. Halpin as necessary, and subsequent events have proved their value.

"R. A. S." next points out that the engine must have been altered between the runs. It was altered in the following manner. During the first run we had the Halpin brake, weighing 13 cwt., keyed on the crank shaft in place of the fly-wheel. In the second run, on our own brake, the engine had on a fly-wheel weighing 9 cwt. The Halpin brake being the heavier, gave a better turning moment, and we could therefore adjust the Turner-Hartnell governor to the greatest nicety, and get a good speed line on the Moscrop tape. On the second run we had not such a good turning moment, owing to the lighter fly-wheel. We then found that the governor—which had worked steady with the heavy wheel—was unsteady with the lighter wheel—that is, the weights moved out and in at every revolution. The unsteady turning moment in the second run—shown by the Moscrop—is no doubt partly due to the backlash in the two universal couplings necessary when a brake is separate from the engine, when such as those used at Newcastle are employed.

The variation in the point of cut-off could have been remedied by tightening two bolts in the governor that are provided for the purpose, but on tightening these screws very slightly the Moscrop speed line showed that the action of the governor was more sluggish, and that the speed varied 1 to 2 per cent. before the governor moved the cut-off excentric. We tried to remedy this by tightening the governor springs, thus increasing the speed, but got little benefit. We got the best line with the governors slack. It was now getting late in the day, and we had no further time for governor adjustments; therefore we started, with the governors slack, on our second run.

When we took our first set of diagrams, during the second trial, we found that the governor weights were shifting every revolution, but more at one end than the other, hence we got the difference in cut-off and average pressure.

"R. A. S." next wishes to know why we changed the area of the fire-grate. It will be seen that the first run was made with only 2 square feet of grate area, which was small, considering the power developed; but during this run the chimney went through the roof of the shed, and we had a good draught. The second run was made in another shed, where the chimney did not pass through the roof. Here we naturally found greater difficulty in making steam; therefore we took out three narrow fire-bricks, and enlarged the grate ½ square foot.

Then "R. A. S." next turns his attentions to what he terms Mr. Halpin's "mare's nest of unusual proportions;" he states that Mr. Halpin finds that the compensating levers put a load on the engine. Here "R. A. S." is wrong again; what Mr. Halpin finds is exactly the reverse, viz., that the compensating levers tend to take the load off the engine. "R. A. S." next asks is it possible that the whole engineering world have been astray on brakes for the last half century? We would not say the whole, as there are a few wise engineers who won't use Appold levers on their brakes, but certainly the engineers of the R.A.S.E. have been astray.

"R. A. S." then goes on in a very learned way to explain how Mr. Halpin found this "mare's nest;" now we dare say, that to any one who is not well versed in brakes, the apparently specious reasoning of "R. A. S." might go down as gospel, but it is quite evident to us that "R. A. S." has yet a very great deal to learn about brakes before he can teach Mr. Halpin. At present "R. A. S." resembles a blind man endeavouring to lead a man who *can* see.

We have already taken up more of your space than we had intended, but with your permission we may at another time enlighten "R. A. S." on this brake question, as he is evidently groping his way in the dark. At the close of his letter "R. A. S." tackles Mr. Halpin for putting spring balances, &c., on the brake; here "R. A. S." is wrong again. Mr. Halpin did not put this gear on: we had it on weeks before he came down, and he made the test on the brake as he found it.

In reply to Mr. St. Lawrence, we may say that we have much pleasure in answering his questions. The extra weight was put on the brake to balance the error. Under all circumstances where Appold levers are employed and the brake blocks lubricated with water, as at Newcastle, there is more or less error in the brake in favour of the engine, which error we are able to measure by the spring balance.

As we wished to get a correct result, and wanted that result to be about 20-horse power, we had to put on the extra weight. We have no faith in any of the Newcastle results, as the error due to the unmeasured force at the inner ends of the Appold levers was not taken into account. If it had been, we would not have got 20·7-horse power with our engine with the weights given.

J. and H. McLaren.

Midland Engine Works, Leeds, December 14th.

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Sir,—Having had a good deal to do with testing engines by means of friction brakes, I am very much interested in the discussion now going on in your paper.

I have frequently heard very disparaging remarks made about friction brakes in general, and those of the type used by the Royal Agricultural Society in particular. In numerous discussions I have always stuck to the absolute truthfulness of such brakes when properly constructed, and their results correctly estimated. The question, however, is how are the results to be estimated, and chiefly the point in dispute is the effect of the compensating lever; and this brings me to the object of my letter, viz., that I have found the following method of studying the problem makes it quite clear to my mind, and perhaps may be of assistance to some of your readers.

Suppose the brake—of the type shown in Fig. 3, page 470 of your last issue—to be in action, and to have settled down into fairly steady running, look upon the whole combination of brake blocks, straps, weights, rods, and levers as one rigid body, and to all intents and purposes they practically are. What pressures are acting on this supposed rigid body? Two pressures; first the weight lifted, and secondly the pressure of the upper end of the compensating lever against the stop. To make an accurate calculation of the horse-power developed it is necessary to include the latter, as although in a properly constructed brake it may be only a small fraction of the total load, still it must of necessity be something, and in some instances it might be a very material amount; in fact, no brake test that ignores it can be perfectly accurate. The pressure on the end of the compensating lever may be either a plus or minus quantity, according to the construction of the brake.

James Atkinson,
Managing Director.

The British Gas Engine and Engineering Co., Gospel Oak, London, N.W., December 12th.

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Sir,—I see by a slip of the pen I say that Mr. Halpin holds that the tension levers in the R.A.S.E. brake augment the load on the engine. I should have said "reduce" the load. The context of my letter makes this clear, but the correction can do no harm.

Westminster, December 13th. R.A.S.

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## BAND SAWS.

Sir,—In your last issue a correspondent, "J. R.," asks why it is that band saws crack and break. This is apparently a simple question, but it admits of a great many answers. The chief causes of fracture may be set down as follows:—(1) Improperly or badly constructed machines. (2) Bad saws. (3) Saws of too thick a gauge for the diameter of the wheels. (4) Saw wheels too small, too heavy, or out of balance. (5) Want of elastic tension in mounting the saw wheels. (6) Too great or sudden a tension, or wheel covering worn or out of order. (7) In overcoming the inertia of starting the top wheel, and from the top wheel overrunning the bottom wheel and saw. (8) From the expansion of working and omission to loosen the saw blade, as it contracts after finishing work. (9) Improper method of receiving the back thrust of the saw. (10) From imperfect brazing, and the joint being thicker than the other part of the blade. (11) From chips dropping between the blade and the bottom saw wheel. (12) Insufficient guides for the saw as it enters or leaves the cut. (13) Improper teeth or width for the wood or work to be done. (14) Improper and uneven sharpening and setting. (15) Improper speed. (16) Improper working, such as forcing the saw, using dull saws, &c.

My time and your space will not permit of my attempting to tell him how to obviate these difficulties, but if he will communicate with me, I will send him some printed matter that will assist him.

The Author of "Saw Mills," &c.

London, December 10th.

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## THE DRAUGHTSMAN'S PROVIDENT SOCIETY.

Sir,—It is essential that a knowledge of this Society should come to all draughtsmen, and for that reason I ask you to allow me to continue the correspondence which has taken place on the subject in your paper.

The Society is now formed, and only awaits the sanction of the Registrar of Friendly Societies to its rules. A public meeting will be held on January 9th, 1888, at St. James's Hall, Piccadilly, at half-past seven o'clock, to which all draughtsmen employed in the architectural, engineering, surveying, and kindred professions are invited. Each person who attends that meeting will be presented with a copy of the rules of the Society, and, of course, will be asked to become a member. The objects of this gathering are the public acceptance of the rules which a former meeting empowered a committee to draw up, and to bring together those who are likely to be interested in the movement.

There are three benefits in the Society, viz., a sickness, a loan, and a death fund. To benefit by the sick fund, a person must contribute a certain payment, which his age will govern, per quarter, and during illness he will receive £1 or £2 per week for the first thirteen weeks, and half these amounts for the next thirteen, according to the rate of his subscription. If a member has paid into the death fund, at his decease his relatives may demand £10 or £25, again according to the rate of the subscription.

The payments to these funds are regulated by a set of tables, a copy of which the secretary, Mr. Middleton, St. James's Hall, Piccadilly, will forward to any one wishing to join. The loan fund can only be enjoyed by those who are members of one or other of the other funds. It is to provide for those out of employment. The contribution to it is 1s. per quarter, and £10 may be borrowed without interest, but the Society will require reasonable security. The loan may be paid back in an easy manner.

To encourage men to join quickly, the first hundred applicants will be admitted without entrance-fee, afterwards 5s. will be charged. The Society, to protect itself, must have a medical certificate from each one, reserving to itself the right to reject those who are likely to be always ill. No member will be allowed to claim on the sick fund until six months have elapsed from the date of his entrance, and in the case of the death and loan funds twelve months.

Such, Sir, is the Society which has been formed. It is one that is much needed, and I trust that you will allow me space in your columns to draw the attention of engineering draughtsmen to it.

W. A. Chambers.

44, Battersea-rise, S.W., December 12th.

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## FREE TRADE AND NO TRADE.

Sir,—Some years ago Mr. Cobden and others proposed a system by which trade all over the world should be free. He predicted that if we set the example by freeing our imports, in ten years all other countries would follow us. On the strength of that fallacious prediction. Sir Robert Peel and others passed a measure freeing all imports, save a few in which there was no home competition.

With a few insignificant exceptions, that system of free imports is all that has ever been realised of the original scheme of Free Trade.

These remarks are elementary, but needful after Mr. Brett's letter in your last issue. In talking of free imports as Free Trade, he is in good company, for though it is to be regretted that the latter phrase should have quite lost its original meaning, it is used in this restricted sense by the majority of statesmen.

Mr. Brett has, however, with others, not only forgotten the real meaning of Free Trade, but speaks of free imports as if they, and they alone, were ever wished for or promised. In this he ceases to be a Free Trader.

Might I suggest that in any future letter Mr. Brett should carefully define the new school he seems to represent? For in any discussion on the subject it seems important to know whether one is dealing with the principle of Free Trade or the principle of Free Imports.

Roger T. Smith.

5, Reginald-terrace, Leeds, December 14th.

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## SOME DEFECTS IN FURNACES COMMONLY KNOWN AS DESTRUCTORS.

Sir,—I thoroughly concur with the views expressed by "A.M.I.C.E." in his letter which appeared in your last issue. In the first place, I may say I am in no way interested in any system for the disposal of the refuse of towns, but I have fully investigated the subject from a sanitary point of view, and therefore hope that you will give me space for a few remarks thereon. Cremation is now generally admitted by sanitarians to be the best method of dealing with the dust and waste matter resulting from our large populations.

The first practical difficulty sanitary authorities at present meet with is the excessive cost of erecting the furnaces, which, although of simple and inexpensive construction, are at present the subject of patents. The next difficulty that has to be contended with is the interruption of the fine dust in its passage to the chimney, without baffling the draught necessary to ensure thorough combustion. To attain this object many methods have been tried. Amongst others, a horizontal flue with cross walls is provided, in which a considerable portion of the dust is deposited; but in my opinion sufficient provision has not been made in the flues I have seen for easily removing this fine dust, which I consider ought to be removed daily. Several furnaces have been invented and patented for burning the combustible and deodorising the incombustible gases produced in the destructor furnace. Amongst these secondary or supplemental furnaces may be mentioned those of Pickard (1880), Pease and Lupton (1881), Richmond and Birtwistle (1885), and Jones (1885). All of these furnaces are no doubt a step in the right direction, as they have been designed with a view to destroying the empyreumatic vapours, which would otherwise escape through the chimney shaft, to the inconvenience of the inhabitants of the surrounding neighbourhood. The latter—Jones'—furnace has been brought into prominence, as it is used in conjunction with the Fryer's destructor furnace, which seems to be the one most generally adopted. Furnaces on this plan are now being erected, or are contemplated, at Battersea, Hampstead, Hornsey, and other places. With regard to the financial question, it seems probable that when the natural term of Fryer's patent expires—August 5th, 1890—and the construction of these furnaces is thrown open to public competition, they will be more generally adopted.

Stratford, E., December 14th. Another A.M.I.C.E.

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## LATENT HEAT OF STEAM.

Sir,—In reading consecutively your issues of September 9th on "Generation of Steam," and November 18th on "Engines at the Royal Agricultural Show, Newcastle," I was struck with the two different values given in these articles for the latent heat of steam at 212 deg. Fah. On page 206, "Q." gives the latent heat of steam at 212 deg. as 965 deg. Fah.; and on page 403, the report of Sir F. Bramwell and Mr. Anderson gives 966·6 deg. Fah. On looking up my text-books on the steam engine, I find the following five values for latent heat given by the various authors:—Maxwell, on "Heat," page 136, 965 deg.; Holmes, on "Steam Engines," page 61, 965·7 deg.; Northcott, on "The Steam Engine," page 57, 966 deg.; Goodeve, "Steam Engine," page 71, 966·6 deg.; and lastly, Everett's, "Steam and Steam Engine," page 13, 966·9 deg. Can any one tell me which is the value mostly used by engineers?

Uxbridge, January 6th. Latent Heat.

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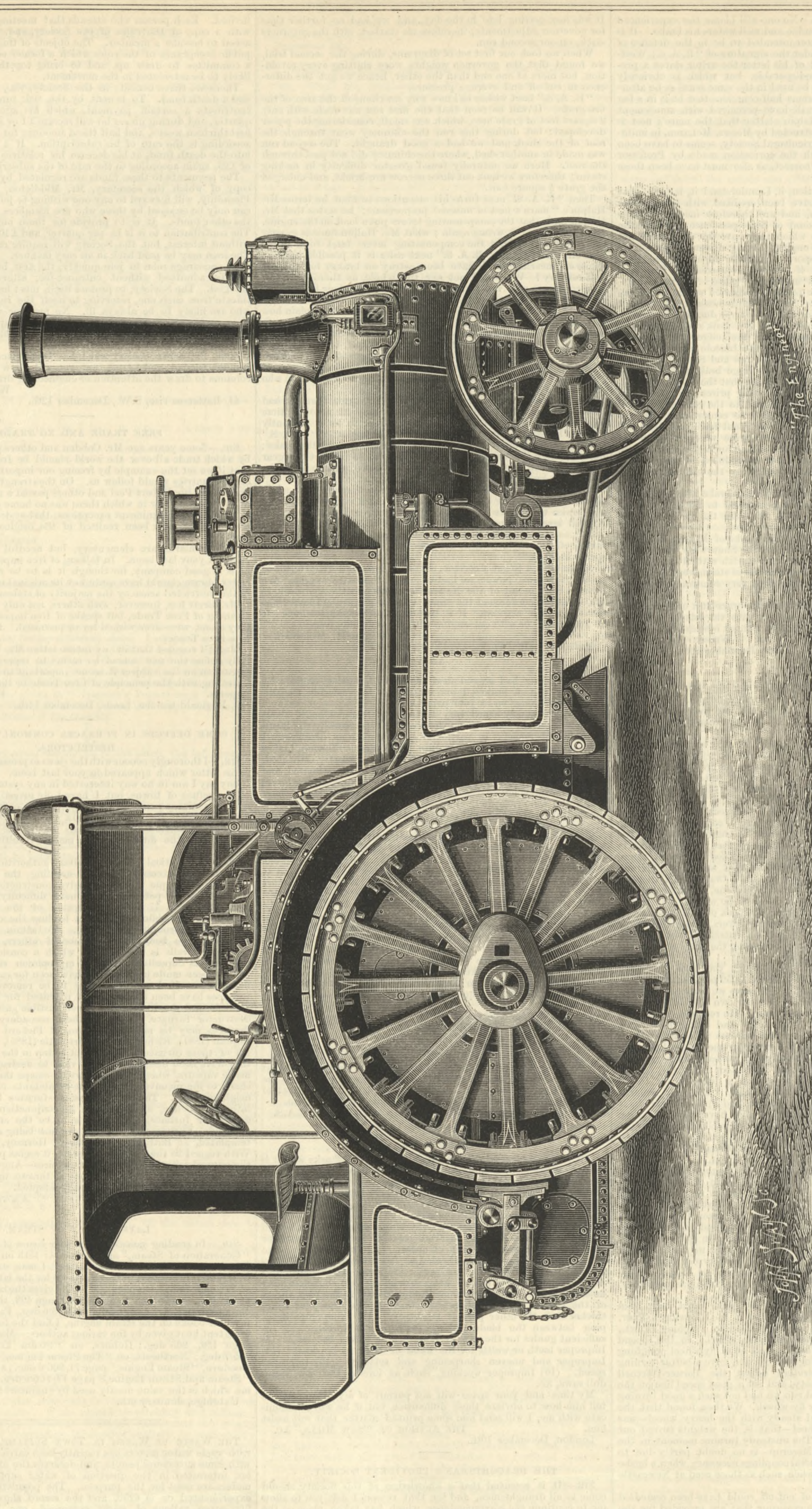
The Waste of Water in Town Supplies.—An experiment with waste water meters has recently been carried out in Plymouth with some surprising results, and deserves the attention of all who are interested in the question of water supply. The Deacon meters are used for the purpose. The population of the district experimented on is 6250, and the record shows that for every fifty-seven gallons of water consumed, one hundred and five gallons were wasted. In other words, about twice as much water was wasted as was turned to use. In one part of the district the waste was three times as great as the actual consumption! No wonder that, under such conditions as these, the water supply fell short in Plymouth during the long, dry summer. Without any doubt the same revelations would follow tests in London.

# HIGH SPEED ROAD LOCOMOTIVE.

MESSRS. J. AND H. McLAREN, LEEDS, ENGINEERS.

(*For description see page 500.*)



## FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

PARIS.—Madame BOYVEAU, *Rue de la Banque.*
BERLIN.—ASHER and Co., 5, *Unter den Linden.*
VIENNA.—Messrs. GEROLD and Co., *Booksellers.*
LEIPSIC.—A. TWIETMEYER, *Bookseller.*
NEW YORK.—THE WILLMER and ROGERS NEWS COMPANY, 31, *Beekman-street.*

## PUBLISHER'S NOTICE.

*** *Next Friday* (*December 23rd*) THE ENGINEER *will be of a special character, and will contain Two Supplements, one being an Engraving of a Midland Railway Express Engine, printed by a new process on tinted paper; while the other illustrates a very powerful Compound Mill Engine by Messrs. Buckley and Taylor, of Oldham. The impression will also contain more than the usual amount of interesting matter. Advertisements for the above issue should reach the office by the 19th instant.*

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THE ENGINEER, December 16th, 1887. PAGE



## TO CORRESPONDENTS.

**Registered Telegraphic Address "ENGINEER NEWSPAPER, LONDON."**

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

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

W. J. T.—*We are not aware that any drawing of the Cornwall in its original condition has been published.*

H. W. O.—"*Annales Industrielles*" *and* "*Genie Civil,*" *both obtainable from H. Grevel and Co., 33, King-street, Covent Garden.*

FAGERSTA.—*In the book giving the results of the experimental inquiry into the mechanical properties of this steel, Mr. Kirkaldy gives the hardness in the shearing stress series, as shown by the amount of detrusion before rupture. This amounted to from 0·193in. to 0·323in., in four sets of specimens sheared by double shear after the manner of a rivet in a butt joint with double straps.*

M. E.—(1) "*Practical Mathematics and Trigonometry,*" *by Francis Campin—Weales' Series.* (2) *If you stick to your studies and to your drawing—not drawing simply from copies, but drawing actual machines from memory, and making a complete set of working drawings, for instance, of an engine, and not from a copy, if you do this for a good part of your leisure, then it would probably be most useful to you to gain more practical experience by going to sea now. Get the practical experience by all means—for this you depend on other people to a great extent; but for the continuation of your theoretical education you must or may depend upon yourself. It is in your own hands always.*

### SUBSCRIPTIONS.

THE ENGINEER *can be had, by order, from any newsagent in town or country at the various railway stations; or it can, if preferred, be supplied direct from the office on the following terms (paid in advance):—*

*Half-yearly (including double numbers)* .. .. .. £0 14*s.* 6*d.*
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*If credit occur, an extra charge of two shillings and sixpence per annum will be made.* THE ENGINEER *is registered for transmission abroad.*

*A complete set of* THE ENGINEER *can be had on application.*

*Foreign Subscriptions for Thin Paper Copies will, until further notice, be received at the rates given below:—Foreign Subscribers paying in advance at the published rates will receive* THE ENGINEER *weekly and post-free. Subscriptions sent by Post-office order must be accompanied by letter of advice to the Publisher. Thick Paper Copies may be had, if preferred, at increased rates.*

*Remittance by Post-office order.* — Australia, Belgium, Brazil, British Columbia, British Guiana, Canada, Cape of Good Hope, Denmark, Hawaiian Islands, Egypt, France, Germany, Gibraltar, Italy, Malta, Natal, Netherlands, Mauritius, New Brunswick, Newfoundland, New South Wales, New Zealand, Portugal, Roumania, Switzerland, Tasmania, Turkey, United States, West Coast of Africa, West Indies, Cyprus, £1 16s. China, Japan, India, £2 0s. 6d.

*Remittance by Bill on London.*—Austria, Buenos Ayres and Algeria, Greece, Ionian Islands, Norway, Panama, Peru, Russia, Spain, Sweden, Chili, £1 16s. Borneo, Ceylon, Java, and Singapore, £2 0s. 6d. Manilla, Sandwich Isles, £2 5s.

### ADVERTISEMENTS.

*** *The charge for Advertisements of four lines and under is three shillings, for every two lines afterwards one shilling and sixpence; odd lines are charged one shilling. The line averages seven words. When an advertisement measures an inch or more the charge is ten shillings per inch. All single advertisements from the country must be accompanied by a Post-office order in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.*

**Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon in each week.**

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

## MARRIAGE.

On Wednesday, the 16th of November, 1887, at Pretoria, Transvaal Republic, by special licence, HARRY WILLIAM MILLER, M.I.M.E., only son of the late Stephen Miller, of Bread-street, London, to LEONORA, second daughter of E. Jacobs, Esq., of Broomhill, Sheffield.

## MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 20th, at 8 p.m.: Ordinary meeting. Paper to be further discussed:—"Electrical Tramways: the Bessbrook and Newry Tramway," by Edw. Hopkinson, M.A., D.Sc., Assoc. M. Inst. C.E. Paper to be read, time permitting:—"The Use and Testing of Open-hearth Steel for Boiler-making," by the late Hamilton Goodall, Assoc. M. Inst. C.E.

METEOROLOGICAL SOCIETY.—Wednesday, 21st inst., at 7 p.m., at the Institution of Civil Engineers: Ordinary meeting. Papers to be read:—"Mean Temperature of the Air at Greenwich from September, 1811, to June, 1856," by H. S. Eaton, M.A., F.R. Met. Soc.; "Report on the Phenological Observations for 1887," by the Rev. T. A. Preston, M.A., F.R. Met. Soc.; "Earth Tremors and the Wind," by Professor John Milne, F.R.S., F.G.S.; "Pressure and Temperature in Cyclones and Anticyclones," by Professor H. Allen Hazen.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—Wednesday, 21st inst., at 7 p.m., at the Town Hall, Westminster: Ordinary meeting. Paper to be read and discussed:—"The Roof of the National Agricultural Hall, Kensington," by Mr. A. T. Walmisley, M I.C.E.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—The fourth general meeting will be held in the Lecture Hall of the Literary and Philosophical Society, Newcastle-upon-Tyne, on Monday, 19th inst., at 7.45 p.m. Paper to be read:—"The Compound Steam Turbine and its Theory as Applied to the Working of Electrical Dynamos," by the Hon. C. A. Parsons.

## DEATH.

On the 9th inst., HAMILTON WELDON PENDRED, C.E., aged 49.

# THE ENGINEER.

*DECEMBER* 16, 1887.

### THE AGRICULTURAL ENGINEERS' ASSOCIATION.

THE Association of Agricultural Engineers, though perhaps not very widely known, is nevertheless an association of considerable influence with the community it represents. It does not come obtrusively before the public in any way, but quietly occupies itself from year to year on matters chiefly concerning the business side of agricultural engineering, and in the endeavour to obtain reform or redress in different directions. It always meets for business purposes during the Smithfield Club Cattle Show week, if at no other part of the year. It also dines during that week, and it is in the speeches after this annual dinner that something concerning the work of the Association may be heard by those not taken into its confidences during the year. On the 7th inst. the chair at this annual dinner was filled by Mr. H. D. Marshall, of Gainsborough, who, as on previous occasions, did honour to the Association in speeches which were attentively heard by men much interested in the subjects with which he dealt.

It appears that during the past year the Association has succeeded in persuading the Council of the Royal Agricultural Society to reduce the high charges it has made for space at its shows since that at Kilburn; and although it may seem hardly fair to expect the Royal Agricultural Society to make much reduction, considering that the Association has succeeded in getting 110 out of 136 regular exhibitors to take but half the space they used to take, it is not really unfair. The agricultural engineers provide a very large proportion of the whole of the attractions of the Royal Society's exhibitions, always at very great direct cost, sometimes at very considerable loss, but the Society only expends upon this section of its supporters a small proportion of the large sum which it devotes every year in the encouragement of the combination of "practice with science." So large a proportion is awarded to the cattle and stock exhibitors, that but a comparatively small sum goes to agriculture as affected and effected by implements and machines. The past year was an exception, but not in so marked a degree that its repetition should not be expected. At the Newcastle Show a large number of the best known firms only exhibited about half the quantity of machines they had been accustomed to exhibit for some years; but the ground covered was quite large enough, and the reduction in the quantity of things shown was no loss to any visitor, for the extra numbers formerly shown were only duplicates.

As bearing on the charges made by the Royal Agricultural Society, Mr. James E. Ransome mentioned that the Newcastle Show resulted in a loss of £2000. Another subject upon which the Association—or rather its Council, for the complaint is made that the members take very little interest in the doings of the Association—work earnestly, is the reduction of railway rates for agricultural machinery and ironwork. Of this something more may be heard at an early date, as the different railway companies have agreed to receive a deputation from the Association. The licensing of traction engines has also formed the subject of action by the Association. Alterations in local byelaws on this subject are very urgently needed, not necessarily for any relaxation in the restrictions which are imposed on the working of these now very necessary engines, but for the purpose of removing vexatious interference with their running through the differences existing between the rules imposed under the licences granted in different counties. At present each county grants or withholds licences, and four adjoining counties may, and in some cases do, impose very different rules as to times of working. It may thus happen that the owner of an agricultural traction engine, working over a comparatively small area, may have to hold four licences, and have great difficulty in making arrangements to move from one county to another because of the rules as to hours of working. Surely agricultural operations cost enough in this country without adding to them by imposing entirely useless restrictions; and all must agree with the Association in its demand that one licence shall be sufficient for one engine, and that the hours for working shall be the same over the whole country. Mr. Marshall also spoke of the injustice of charging rates on agricultural machinery.

From these questions Mr. Marshall turned to those which may be said to interest every one, namely, trade depression, our foreign trade, and the foreign tariffs on our manufactured goods. He disclaimed speaking on the latter part of these subjects as representing the Association, or as introducing political discussion, but he desired to say a few words upon it as a matter of much interest to English people, and of great importance to all who do any foreign trade. We may refer to Mr. Marshall's remarks without any intention of taking up political questions in our columns. Simply as a matter of great importance to manufacturing engineers of all branches, it is desirable that the remarks of one of Mr. Marshall's great experience in the manufacture and export of first-class steam machinery should not pass unnoticed. With reference to one large agricultural and, particularly, wheat-growing country, namely, Russia, Mr. Marshall told his hearers that in 1886 his firm had sent out engines and machinery to the value of £115,000. As a result of the increase in the tariff on this class of import, this had fallen to £83,000 in 1887; and although he hoped to increase this next year it would not be in consequence of any decrease in tariff.

In another country, from which England imports manufactured flour, he had been repeatedly invited to build works to construct machinery; but as he had no wish to establish himself there, a duty had been as a consequence put on steam engines, machinery, and mill-work. It was within his knowledge that had he been able to say that a duty on manufactured flour from that country would be levied at English ports, this duty would never have been put on British machinery. He could say positively that in all cases the duties imposed by foreign countries on our machinery was almost all paid by the British producer, and these tariffs were consequently making it more and more difficult for English engineering firms to maintain their foreign trade. The only possible way of maintaining it was by reducing profits to the very lowest, and by reducing cost of production, to both of which there was a limit. He considered we had now arrived at a stage of depression which few had ever known before, and thought our fiscal policy should be taken into consideration. Times were not as they used to be, and if our Free Trade policy was right years ago, it was quite possible that upon investigation it would be found that it was unsuited to the present times. To transact business now was almost an impossibility, as obstacles cropped up on every side. Russia had imposed another duty, and it was possible that that would cause a decrease of trade as in the case with Italy. He concluded by saying, that with a "fair field and no favour," few complaints would be heard.

Mr. Joseph Ruston, of Lincoln, touched upon this subject, and traced the depression in the engineering and manufacturing trades to our own agricultural depression, but assumed that any duty put upon imports into England would be paid by the importers. He said, however, the question was how to rectify this depression from which agriculture was suffering so terribly. The difficulties of the situation—and they were many—must be looked in the face. We had to purchase half the wheat we used for home consumption from abroad, and it was therefore very questionable whether the people would submit to a duty on corn. He gave a list of the various articles which might be taxed, and also of those which might not, and said he thought the time had come when the whole matter should receive consideration at the hands of her Majesty's Government. Many other remarks might be mentioned as indicating that amongst the engineering firms of high repute and great experience the feeling that English trade in machinery, as well as in other things, is being materially affected by foreign tariffs is common, and that, rightly or wrongly, things would be very much improved, without any counteracting disadvantages, if foreign manufacturers were made to feel the same difficulties in reaching the British consumer as we find in reaching theirs.

It was not to be supposed that a question of such general interest as the performance of the competitive engines at Newcastle would be passed over in silence. Mr. McLaren referred to the subject, and argued that enough was known to prove that the brakes used gave untrustworthy results. It is clear from the correspondence now going on in our own columns that a similar opinion is held by engineers who have no special interest in the matter other than one based on the desire that measuring instruments intended to give precise results should themselves be instruments of precision. It therefore seems desirable that fresh trials should take place at no very distant period, not necessarily next year however, when dynamometers should be used to measure the power given out by the engines, the accuracy of which should be beyond dispute. We prefer, for the moment, to reserve to ourselves the views which we hold concerning the merits or demerits of the Royal Agricultural Society's brakes; but we have no hesitation in saying that it is essential that measuring instruments used in public competition ought to be far above suspicion. We fear, however, that if the truth were plainly stated, the Royal Agricultural Society does not possess any measuring apparatus whose records are universally accepted as above doubt. Part of this is due to economy, which has led to neglect; part to the circumstance that most of the appliances are now antiquated, and thus, however really good, their mere age throws a doubt on them, which is objectionable.

### STRUCTURAL STIFFNESS.

So much is said, written, and calculated in the present day about structural strength, that it might easily be supposed that structural stiffness was a thing of no moment, something concerning which engineers did not trouble themselves. As a matter of fact, however, the stiffness of many structures is far more important than their strength. This truth is often lost sight of, and it is noteworthy that very little indeed has ever been written on the subject, and that very few direct experiments on the stiffness of materials, or intended to ascertain the best way of applying it, have been made. Experiments in elasticity must not be confounded with the species of inquiry concerning which we write; for although want of stiffness may be due to the presence of too much elasticity in a structure, it does not necessarily follow that the converse of the case must be true, and that a combination of non-elastic materials must be stiff. There are three ways in which stiffness may be obtained. First, it may be had by using redundant material; secondly, it may be had by using rigid material; and lastly, it may be had by adopting the method of initial stress, and in many, if not in most, cases this last will be found at once the most scientific and the most elegant way to attain the desired end. All three methods, however, deserve a consideration which they have not received, to the end that the engineer employed in designing a structure may have some information as to the best or the most economical arrangement to adopt.

To make what we say quite intelligible we cannot do better than cite an example. Let it be supposed that a given moderate span has to be bridged, and that the deflection of the bridge has to be kept within certain limits. Now, it is a noteworthy fact that no material, not even the hardest steel, has, if left unstressed, any initial rigidity of stiffness. Put into other words, this means that every material suffers some deformation from every stress to which it is submitted, however small. An admirable example of this is supplied by the mirrors of reflecting telescopes. These are composed of an alloy of tin and copper, extremely hard, rigid, and brittle. Lord Rosse used for his great telescope a mixture of 32 of copper to 14·911 of tin, or four atoms of copper to one of tin. The resulting speculum metal is very brilliant, and has been described as "perhaps the most intractible among metallic bodies, so brittle that it breaks, even in large masses, with a slight blow or change of temperature, and so hard and friable that it cannot be wrought with tools of steel." Apparently a mass of this alloy three or four inches in thickness and of moderate diameter ought to be initially stiff if anything is. Yet it is well known that the most extreme precaution must be used in mounting a speculum or it will become distorted by its own weight. "To many," says Nicholl, "it will seem incredible that a disc of this hard and rigid metal from four to six inches thick can bend save except undersome force purposely applied; while the fact is that it requires the most refined mechanical contrivance to prevent injurious flexure from its own weight. Even a nine inch one, if resting on a ring at its circumference on three screws, or, according to the old plan, pressed by springs against three stops, bearing on its edges, loses its defining power." An example more familiar to engineers is that supplied by the large horizontal cylinders used in the old low-pressure days in the navy. It was found that notwithstanding the use of ribs and stiffening webs, such cylinders underwent sufficient deformation to become perceptibly oval when laid on their sides if they were bored out in a vertical position; and if we are not in error John Penn was the first who adopted a horizontal boring mill for this very reason. Now applying this to our bridge, we see that no matter of what we make it, it will undergo some deflection, if only because of its own weight; and this fact is enough to direct attention at once to the circumstance that mere dead weight alone cannot secure absolute stiffness, although it will tend to that end. We cannot, however, cite any extended or valuable investigation which is intended to supply formulæ for ascertaining the minimum quantity of material that will give sufficient stiffness to a structure for a minimum expenditure of money, although there are abundant examples of such investigations, referring not to stiffness but to strength. If the amount of admissible deflection is stated, then it becomes possible, at least by the old trial and error systems, to design a cast or a wrought iron girder bridge in which, without any initial rigidity, there would be enough of stiffness to satisfy the conditions; for although mere weight of metal will not give stiffness in the fullest degree, the weight of the metal and its corresponding stiffness may be plotted in a curve which has no limit.

In our bridge it is possible so to introduce initial stresses that there shall be no deflection whatever under the passage of a load. All that is necessary is to place the top and bottom members in compression and tension to a greater degree than the load can place them in compression and tension, and the stiffness aimed at will be secured. The principle involved is identical with that not long since described in our correspondence columns under the title, "A Problem in Strains." Let us, for example, use a bowstring girder. If the string is simply rivetted on to the bow, the rigidity of the structure may be small; but let the string or lower boom be fitted with tightening screws, so that a considerable initial stress shall be put on both bow and string, and we shall then have great rigidity for little material. This principle has been extensively adopted in large span bridges and roofs in timber. Wood is anything but stiff; and girders of wood, such as used to be, and are even now, freely used in North America, would have been unfit for their work were it not for the skill with which iron tension rods were screwed up, or for the greater skill with which timber trusses without a fragment of iron in them were pinned and wedged until the whole structure was stretched and rigid as a harp string.

This method of initial tension may be employed with manifest advantage in dynamic as well as in static structures. Thus, for example, the "walking beams" used in American steamboats, consist of a skeleton of cast iron placed in compression by a wrought iron or steel outer portion or hoop shrunk on hot. It is extremely difficult to bend such a beam. In putting into machines members intended to prevent angular vibrations or deflections, it is often the practice to employ cast iron frames, put in place and rivetted or bolted up. Such diagonal stiffness may be better than nothing, but it cannot be compared in efficiency with diagonal wrought iron or steel stays properly set up by the aid of nuts, or gibs and cotters, to begin with. Diagonal staying of this kind is much used in modern marine engines where lightness of framing is essential; and wonderfully rigid structures are thus produced by the aid of literally a few pounds of steel. Much greater rigidity, indeed, than could be secured by a hundred times the weight of cast iron employed without initial tension. Coupling rods for locomotives are in the States sometimes trussed, and great vertical stiffness is thus obtained. In no form of mechanism, perhaps, is rigidity more needed than it is in machine tools, and in none is it found so frequently absent. So long as the beaten track is followed all is well, and excellent lathes and planing and shaping machines can be had from all the principal makers. But if a machine tool is ordered to do some special class of work out of the ordinary run, mistakes are sure to be made by all but a very few firms indeed. The tools produced are quite strong enough, it is true, but much more than strength is required. Stiffness, absence of shake, and quiver, must be prevented. And the means taken to prevent them are often ridiculously inadequate. Not long since we saw a wheel lathe intended to turn up two tires at once. This was apparently a fine heavy machine. The bed, heads, gearing, &c., had plenty of metal in them, and no fault could be found with the design so far; but the tools were carried on cast iron columns, and these and the mode of attachment to the bed were so badly designed, that no good work could be done unless an extremely light cut were taken.

We believe that not nearly enough has yet been made of the initial stress system; and we would suggest that experiments should be carried out with a view to show on broad lines, not only how stiffness can best be secured, but how the greatest value can be had out of a given weight of material. It may be urged that the conditions vary so considerably that it is impossible to state any formulæ which would be generally applicable, and we are not prepared to contest the point; but it is nevertheless a fact that a great deal of information of an extremely useful character might be obtained, not necessarily by the aid of the testing machine, but by the graphic method. What, for example, is the most economical angle for the diagonal struts of a structure whose weight must be kept, other things being equal, as small as possible? Is a diagonal stiffener best as a tie or as a strut? When is it better to use two diagonals than one for doing the same work? and so on. A good deal that has been written about bridges and roofs will apply to steam engine or crane frames, but not all. There is plenty of room for original inquiry still, and we have no doubt but that a proper investigation of the whole problem would be appreciated by engineers. The general principle to be observed, it may be well to say, is that the initial stress shall in no case be overpowered by the forces otherwise acting in the machine, girder, or roof.

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### TRIAL OF NEW ITALIAN-MADE STEEL PLATES.

The first trial of the solid steel armour plates made at the Italian factory at Terni is reported in the daily papers. We hope shortly to give our readers some details of this trial. In the meantime we have merely the report of the telegram of Admiral Cottrall to the Minister of Marine. "First shot fired, excellent results. Penetration and bruising—*effetti contundenti*—less than that observed in all corresponding previous trials," and "second shot struck too high, but also gave excellent results. Penetration: first plate, 18 cm., about 7in.; second plate, 25 cm., about 10in. Metal excellent; no splintering. Protection of cushion complete. Commission entirely satisfied"—see *Standard*, December 13th. These plates are the first made at Terni by the "Societá Anonima degli Alti Forni Acciaieria e Fonderia de Terni." The firm of Schneider and Co. are interested in these works; consequently the plates may be regarded as identical with those of Creusot, and made with the benefit of the skill and experience acquired at Creusot. To form any estimate ourselves of the measure of success achieved, it is necessary to know the nature of gun and projectile, dimensions of plate, velocity of shot on impact, &c. There can be no question, however, that the results must be good, the Italian officers having had peculiar experience, and being very capable judges. In England our own plate makers are leaning more to steel-faced armour than was the case a year since. It would be very interesting to try the respective powers of steel-faced and solid steel armour. This we cannot think will be done in the coming trials at Portsmouth, unless Messrs. Schneider, the only experienced makers of solid steel plates, are encouraged to compete. No one wishes more sincerely than ourselves to see steel-faced plates preferred, not only by England, but by foreign Powers; but this preference should be based on proved superiority, and this can never be so long as we only try the plates made by English firms who have little or no special experience in solid steel armour. The more steel factories are developed abroad, the more necessary it is that England should take the lead in armour manufacture. To establish a claim of superiority, it is necessary to encourage competition with foreign makers, and also to publish reports of our experiments. At present a course is being followed calculated to injure this branch of industry. It is to be hoped that we may shortly change our system, or we may expect to say good-bye to the state of things under which our factories were supported by foreign orders in a considerable measure.

### OUR COAL PRODUCTION.

It will be months before we have official accounts of the extent of the output of coal in the year that is now so near its termination, but there are some data which allow an estimate to be formed. The official returns prove that there has this year been an increase in the export trade—an increase of not much short of a million tons; and for the year as a whole it is probable that over 22,400,000 tons will have been sent out, whilst the increased quantity shipped for the use of steamers engaged in the foreign trade will make the quantity exported in these two ways, directly and indirectly, about 29,250,000 tons, which is a substantial increase on last year's quantity. This is the first indication of the output of coal, and it is satisfactory. We have also the returns to aid us of the coal imported by sea and rail into the metropolis. In round numbers this may be put at 12,000,000 tons for the year, and the total should be about 150,000 tons more than in the preceding year. In these quantities there are included for export and for metropolitan consumption considerably more than one-fourth of the coal production of the kingdom; and we have seen that there is a substantial increase in the coal so used. But here actual fact fails us, though in one direction we have inferential statements of value. We know that the production of iron and steel is, on the whole, larger, and though the increase is not great, yet there is an increase. We find that the normal growth in the consumption of coal for railway purposes and in the gas manufacture goes on, and though the rapidity of that growth is not so great as it was, yet there is an appreciable enlargement. In some of the other industries there is decidedly a lessened use of fuel, the dulness having restricted production. But when all is taken into account we find that there is the probability of a slight decline in the output of coal; and it may be not unfairly concluded that the chief loss will have been felt by Northumberland, in which the prolonged strike at the beginning of the year lessened the output considerably. Possibly this may have been in some degree counterbalanced by the enlarged output known to have taken place in South Wales and one or two other districts at the time of the strike; but still the indications are such as we have hinted at.

### THE BELGIAN COAL INDUSTRY IN 1886.

The official statistics show that the output was in the Hennequin basin 12,801,540 tonnes—1000 lb.—of the value of 105,453,000f.; in the Namur basin, 384,660 tonnes, worth 2,462,000f.; in the Liége district, 4,099,343 tonnes, worth 34,627,000: together, 17,285,533 tonnes and 142,542,000f., which was less by 152,000 tonnes and 12,076,000f. than in 1885. The average selling price, which kept continually getting lower, was 8·25f. per tonne. The number of pits at work receded to 280 from 285 in 1885, whilst 79 were in reserve and 10 new pits were in process of being sunk. It is thus seen that the reduction in the price of the coal caused the working of the weaker mines to be suspended. The outturn per man was 228 tonnes, or 4 tonnes more than in 1885. The mines employed 100,282 workpeople, or 2813 less than in 1885; of the latter, 1665 were women and boys. From 1883 to 1886 there has been a diminution in the number of women employed of 20 per cent.; of girls, 56 per cent.; and of boys, 10 per cent. The 100,282 workpeople received in wages 78,564,000f., which makes 783f. for each worker, or 29f. less than in 1885. If, however, the reduced number of women, girls, boys, and aged workpeople are brought into account, the reduced amount of wages becomes still more apparent. In the Liége and Centre districts the wages are the highest, and in the Mons and Namur basins the lowest. The day's wages were as follows:—Workmen above ground, 2f. 17c.; those underground, 2f. 94c.; for women, 1f. 70c.; boys, 1f. 45c.; girls, 1f. 25c.; the last three for underground work, which would make that the actual miners above sixteen years of age earn 3f. 25c. per day. But if the year's earnings are divided over 300 working-days, the day's wages would only amount to 3f. 7c. Out of the total of the value of the output for 1886 of 142,542,000f., the gross earnings amounted to 5,151,000f., which makes 1,786,000f. less than in 1885. The earnings per tonne therefore were 30c. as compared to 40c. in 1885. During the year 1886 there was a sensible reduction in the import and a trifling increase in the export of coals.

### THE IMPROVEMENT IN IRON AND STEEL.

The improvement in the iron trade upon which we made some remarks two weeks back continues. We say this in face of the sudden drop in the Glasgow and Middlesbrough markets. That decline is due entirely to speculative causes. The excited rise in pig prices on those markets which ensued upon the announcement of a probable reduction in the American tariff was much in excess of the reasonableness of the case, and the decline which this week we are experiencing is only a natural reaction. But the evidences upon which a sound improvement in trade may fairly be based, are fully as favourable to-day as when we last wrote. Shipbuilding orders on the Clyde continue to increase, and it is estimated by some authorities that fully 170,000 tons of this class of work are in hand upon which to begin the new year. American orders for blooms, billets, and other classes of steel are also increasing in Scotland, and one firm is credited with having booked 40,000 tons on American account. The steel plate demand in Cleveland is so heavy that it is difficult to supply it, and makers have advanced quotations 15s. per ton, making ship-plates £7; and steel ship angles have advanced 7s. 6d. per ton, making them £6. More orders are being received at the steel rail mills, and Messrs. Bolckow, Vaughan, and Co., are understood to have this week booked an order for 40,000 tons of rails for the Government of Victoria. Rail quotations have advanced 5s. per ton, the figures in Cleveland and on the West coast being now £4 5s. for heavy sections. Hematites are advancing rapidly, and the demand has so far improved that prices at Barrow have advanced to 46s. 6d. per ton net for mixed numbers and 45s. 6d. for forge. Manufactured iron prices the kingdom over are advancing, and in Cleveland there is a rise on the week of from 2s. 6d. to 5s. per ton.

### ELECTRIC LIGHTING AND INERTIA.

Why does not the electric light advance? This is a question often asked, but not always satisfactorily answered. The following will perhaps throw a little light on the obstacles to be overcome by electricity in its struggle with gas, and the possession which, besides being nine points of the law, is often a strong position of defence against all comers. A certain well-known hydropathic establishment, founded by a philanthropist, worked by a company, and well patronised by the public as well as invalids, is handsomely—nay, artistically fitted and furnished; but it is lighted throughout by gas, although steam power is employed for other purposes. Moreover gas is used in the bedrooms, and the burners are kept lighted, though turned low, during the evening, so that the air at the time of retiring to rest is not quite the most desirable atmosphere for invalids, for whose benefit every conceivable hygienic appliance, as well as sanitary *régime*, is provided. Perhaps those at the head of affairs fear increased expense, and the substitution of a dead loss for a small profit. No; this is not the reason, for an eminent firm of mechanical engineers has gone thoroughly into the economical as well as the technical side of the question, and has submitted an estimate showing an actual reduction of expenditure if the electric light be adopted, and has also offered to supply leads and dynamos, if the company will contract to buy the lamps. In the face of such an offer, what can be the motive for holding back? Surely it can only be that great opponent of all progress, inertia and *laissez faire*. The gas pipes are laid, the gas has done very well until now, and it may continue to serve. But we may ask, when so many means are resorted to for maintaining or restoring health, is it not worth while to overcome this inertia, especially with such strong inducement?

## CHINESE LOCOMOTIVES.

In our impression for November 18th we illustrate a locomotive for the Chinese railway. We now give on page 493 sections of the same engine. In a future impression we shall publish additional drawings and descriptive particulars.

## THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

THE following reaches us from a correspondent, and is dated Philadelphia, December 3rd, 1887:—

The eighth annual meeting of the American Society of Mechanical Engineers was held this week at Philadelphia, and was attended by about 120 members representing some fifteen different States. The session lasted from Monday until Thursday. The latter day was spent in visiting the Bethlehem Iron and Steel Works. The convention was presided over by George H. Babcock, of the Babcock and Wilcox Company of New York. He delivered a very entertaining address, in which he set forth the possibilities of mechanical engineering and the field that it had yet to fill. The first paper read was by John E. Sweet, of Syracuse, N.Y., entitled, "A New Principle in Steam Piston Packing." The discussion upon this paper ended the first day's session, and the afternoon was spent in making visits to points of interest and to manufacturing establishments throughout the city. The second day opened with the reading of the treasurer's report, which showed a membership of 813, and cash receipts for the year 10,586·20 dols. The announcement of officers for the ensuing year was then made, and what had been carried on by mail previous to the meeting of the convention. Horace See, of the William Cramp and Sons' Ship and Engine Building Company of Philadelphia, was elected president; W. T. G. Baker, of the Baltimore Car Wheel Company, Henry G. Morris, of Philadelphia, and C. J. H. Woodbury, of Boston, Mass., were elected vice-presidents; Wm. H. Wiley, of New York, was elected treasurer; the managers of the society are Stephen W. Baldwin, of New York; Frederick Grinnell, of Providence, R.I.; and Morris Sellers, of Chicago, Ill.

Upon the announcement of the election of officers, Mr. Henry I. Snell was called upon to read a paper, entitled "Experiments and Experiences with Blowers." The paper was a very interesting one, and developed considerable discussion. A number of interesting tables were given, showing the velocity of air under pressure and under varying conditions. He also read a paper on "An Economic Method of Heating and Ventilating an Office and Warehouse Building." The next paper was read by Professor Robert H. Thurston, of Cornell University, entitled "Internal Friction of non-condensing Engines." The conclusion reached in the paper was that the internal friction of an engine of this class operated under certain conditions, and having a throttling governor, is constant for all loads, independent of the magnitude of the load and the power developed, but is variable with the speed. A paper was read by Oberlin Smith, of Bridgeton, N.J., on "Power Press Problems." The difficulties encountered in the construction of a perfect press were detailed and discussed by various members.

The afternoon was spent in visiting a few of the larger manufacturing establishments throughout the city.

At the evening session Mr. John J. Grant read a paper upon "The Milling Machine as the Substitute for the Planer in Machine Construction." The claim was made and elucidated that a great economy in cost could be made by the milling machine, and that every part of a locomotive could be as well made by a milling machine as by a planer. The views entertained were not accepted by the entire membership, and an interesting discussion was indulged in. A paper written by Mr. Frank Van Vleek, on "Standard Section Lining," was presented, in which was advocated a uniform system or method to be used in sectional drawings, just as uniformity is now general in geological draughtsmen's work. This paper, like all others, elicited a great deal of discussion, in which the pros and cons were brought out very clearly to the entertainment as well as the instruction of the membership. The secretary read a paper written by Mr. Wm. O. Webber on "Centrifugal Pumps and their Efficiencies." The views upon this paper exhibited a good deal of divergence of opinion.

The third day's session was opened by a reading of a paper by Professor Gaetano Lanza, of the Institute of Technology, Boston, entitled "Friction in Toothed Gearing." The professor presented as conclusions that the relative efficiency of the epicycloidal or the involute form of tooth depends upon the proportions used for each, and that the efficiency of involute gears is not, as has been claimed, independent of the obliquity. The professor presented a paper written by Prof. Jerome Sondericker, of the Institute of Technology, which was "An Investigation as to how to Test the Strength of Cements," in which tables were submitted giving the results of tests on Portland and Rosendale cements by means of compression, tension, and the use of an excentric load. Mr. Henry De B. Parsons read a paper on "Influence of Sugar on Cement," giving three series of tests showing that molasses and sugar mixed with cement in certain proportions retards the setting of the cement, ultimately making it firmer. Mr. John Coffin, of the Cambria Ironworks, Johnstown, Pa., read a paper on "Steel Car Axles," in which the results were given of a number of experiments showing that the chemical energy of the charge of carbon is commensurate with the amount of carbon present in the steel; that the work to be done in breaking up the crystals is commensurate with their size; while the carbon is changing to its non-hardening state a force is presented tending to break up crystallisation, and that at a white heat steel becomes nearly amorphous. This paper, which was considered the most interesting and most important read at the convention, elicited a great deal of discussion, in which the theories and results announced by the reader were corroborated by the experience and observations of others. Mr. Felton read a paper entitled "Results from Steel Tested Shortly after Rolling," in which the conclusion was reached that "after rolling, steel increases in percentage of reduction of area, in percentage of elongation, and in ultimate strength, and decreases in elastic limit." Louis F. Lyne, of Jersey City, read a paper upon "The use of Kerosine Oil in Steam Boilers." The author stated that a boiler could be kept clean by mixing a small quantity of oil with the water, taking care to put the oil in first. James M. Dodge, of Philadelphia, described "a new method of stocking and reloading coal." Orosco C. Woolson, of Newark, N.J., read a paper upon "A Railroad Bed for Bridge Structures." Frank H. Ball, of Erie, Pa., described "an improved form of shaft governor." Discussions on the following topics took place:—"What is the best material for lining brake straps on elevators, cranes, &c.?" "What is the best way to secure tight fit of set screws tapped into heavy parts of a machine?" "What makes the best moulds for complicated steel castings to secure solidity and freedom from shrinkage cracks?" "What is the effect of adding small per cents. of wrought iron or steel scrap in the foundry cupola or ladle?" "What kinds of pig iron give the best results in light castings where easy tool treatment is the essential rather than strength?" These discussions practically ended the meeting. On Thursday the members visited Bethlehem, and were highly delighted with the trip and the large manufacturing establishments visited in the town. The convention will hold its next annual session at Nashville, Tenn. The Society is growing rapidly, and the greatest interest is manifested in its proceedings.

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IF youths do not learn machine drawing now-a-days it will not be for want of practical examples in cheap copies. Mr. T. Murby sends us a copy-book containing thirty pages of lithograph examples, by Mr. W. A. Littlejohn, of machines and details, many of which are satisfactory in form and proportions, but almost all of which have one fault, that the radii of rounded corners or hollows are not given or indicated as necessary with other dimensions. Messrs. Griffith, Farren, and Co., two sets of six sheets of "Studies in Machine Design," by Mr. C. F. Archer, the one set being elementary examples and the other a launch engine with all its details. The examples are all of a practical kind though not of the highest types. Larger rounds are needed in the bearing or journal corners, and more small radii dimensions needed.

## SOCIETY OF ENGINEERS.

### A NEW FORMULA FOR THE FLOW OF WATER IN PIPES AND OPEN CHANNELS.

AT a meeting of the Society of Engineers, held at Westminster Town Hall, on Monday evening, December 5th, Professor Henry Robinson, President, in the chair, a paper was read on "A New Formula for the Flow of Water in Pipes and Open Channels," by Mr. Edgar C. Thrupp.

The author said that having worked out, by means of graphic diagrams, a formula for the flow of water in pipes, based on a large number of experiments by M. Darcy and others, with some by himself, he was induced to try this year how far experiments on the flow of water in open channels—such as those by Darcy and Bazin and Major Cunningham—would be amenable to the same mode of treatment. The results were not only very satisfactory, but unexpectedly threw light upon some points in the question of the flow in pipes which had before been difficult to explain. He had thus been enabled to obtain a general formula, applicable both to pipes and open channels, and taking into account the effects on velocity of the varying relations between hydraulic depth and roughness of surface, in a manner that had not hitherto been done. After describing the experiments of Professor Osborne Reynolds, which brought out the curious fact of a "critical velocity" at which eddies come in, for a limited range of velocities, after which an even flow again takes place, the author described the apparatus he had himself used, and showed the graphic results of experiments which he had also reduced to tabular forms. He then gave Reynolds' formula, and Hagen's, of which latter his own was a modification, the changes introduced having for their object to express the effects of various degrees and kinds of roughness in the surfaces flowed over, with varying hydraulic depths. He concluded by justifying the effort to make a more accurate formula by comparing the results of experiments with results obtained by calculation.

Hagen's formula, as proposed to be modified:—

$$v = \frac{R^{x + y\sqrt{\frac{z - R}{R}}}}{c\sqrt[n]{S}}$$

TABLE No. 1.

Wrought iron pipes $n = 1·80$, $c = 0·004787$, $x = ·65$, $y = ·018$, $z = ·07$

| Reference number. | Diameter in ft. | S. | Velocity in ft. per second. Observed. | Velocity in ft. per second. By formula | Error per cent. | Name of Observer. |
|---|---|---|---|---|---|---|
| 166 | 0·935 | 1428 | 1·296 | 1·435 | +10·7 | Darcy |
| 167 | ,, | 389·3 | 2·782 | 2·943 | + 5·8 | ,, |
| 168 | ,, | 230·9 | 3·868 | 3·949 | + 2·1 | ,, |
| 169 | ,, | 145·9 | 4·902 | 5·096 | + 3·8 | ,, |
| 170 | ,, | 84·03 | 6·673 | 6·769 | + 1·4 | ,, |
| 171 | ,, | 48·92 | 8·852 | 9·355 | + 5·7 | ,, |
| 172 | ,, | 35·62 | 10·522 | 11·156 | + 6·14 | ,, |
| | | | | Mean | + 5·69 | |
| 155 | 0·643 | 4999 | 0·591 | 0·5616 | − 4·97 | ,, |
| 156 | ,, | 2083 | 0·912 | 0·9135 | + 0·11 | ,, |
| 157 | ,, | 775·2 | 1·529 | 1·582 | + 3·46 | ,, |
| 158 | ,, | 363·0 | 2·559 | 2·665 | + 4·14 | ,, |
| 159 | ,, | 172·4 | 3·530 | 3·648 | + 3·37 | ,, |
| 160 | ,, | 84·03 | 5·436 | 5·436 | 0·00 | ,, |
| 161 | ,, | 83·33 | 5·509 | 5·461 | − 0·87 | ,, |
| 162 | ,, | 47·61 | 7·411 | 7·452 | + 0·55 | ,, |
| 163 | ,, | 33·67 | 9·00 | 9·034 | + 0·36 | ,, |
| 164 | ,, | 27·47 | 10·013 | 10·116 | + 1·28 | ,, |
| 165 | ,, | 8·226 | 19·72 | 19·767 | + 0·24 | ,, |
| | | | | Mean | + 0·69 | |
| 143 | 0·271 | 3704 | 0·328 | 0·374 | +14·2 | ,, |
| 144 | ,, | 1515·2 | 0·577 | 0·6155 | + 6·70 | ,, |
| 145 | ,, | 492·6 | 1·171 | 1·149 | − 1·88 | ,, |
| 146 | ,, | 159·0 | 2·182 | 2·149 | − 1·56 | ,, |
| 147 | ,, | 81·96 | 3·117 | 3·111 | − 0·19 | ,, |
| 148 | ,, | 43·76 | 4·442 | 4·410 | − 0·72 | ,, |
| 149 | ,, | 32·18 | 5·292 | 5·230 | + 0·72 | ,, |
| 150 | ,, | 24·62 | 6·148 | 6·070 | − 1·25 | ,, |
| 151 | ,, | 13·94 | 8·438 | 8·324 | − 1·35 | ,, |
| 152 | ,, | 9·38 | 10·535 | 10·374 | − 1·53 | ,, |
| 153 | ,, | 7·204 | 12·034 | 12·013 | − 0·17 | ,, |
| 154 | ,, | 6·408 | 12·786 | 12·823 | + 0·29 | ,, |
| | | | | Mean (Omitting Nos. 143 and 144.) | − 0·76 | |
| 131 | ·0879 | 4544·7 | 0·098 | 0·1466 | +50·0 | ,, |
| 132 | ,, | 1492·5 | 0·302 | 0·272 | − 9·0 | ,, |
| 133 | ,, | 446·63 | 0·509 | 0·532 | + 4·5 | ,, |
| 134 | ,, | 164·20 | 0·889 | 0·9275 | + 4·5 | ,, |
| 135 | ,, | 88·247 | 1·260 | 1·187 | − 5·8 | ,, |
| 136 | ,, | 45·025 | 1·860 | 1·903 | + 2·32 | ,, |
| 137 | ,, | 32·949 | 2·224 | 2·264 | + 1·78 | ,, |
| 138 | ,, | 22·029 | 2·798 | 2·831 | + 1·19 | ,, |
| 139 | ,, | 8·442 | 4·813 | 4·824 | + 0·22 | ,, |
| 140 | ,, | 5·560 | 6·099 | 6·083 | − 0·26 | ,, |
| 141 | ,, | 4·895 | 7·228 | 7·210 | − 0·25 | ,, |
| 142 | ,, | 3·256 | 8·225 | 8·189 | − 0·43 | ,, |
| | | | | Mean (Omitting Nos. 131 and 132.) | + 0·77 | |

| Reference letter. | Tem. Fah. | S. | Velocity in ft. per second. Observed. | Velocity in ft. per second. By formula | Error per cent. | |
|---|---|---|---|---|---|---|
| a | 52·75° | 5·058 | 2·530 | 2·532 | + 0·05 | Wrought iron pipe ·49in. in diameter. |
| b | ,, | 5·662 | 2·514 | 2·325 | − 5·37 | |
| c | 52·50 | 6·095 | 3·294 | 3·185 | − 3·4 | Name of observer, Thrupp. |
| d | 52·25 | 7·178 | 3·012 | 2·912 | − 3·32 | |
| e | ,, | 8·091 | 2·850 | 2·721 | − 4·52 | |
| f | 52·00 | 8·649 | 2·746 | 2·622 | − 4·51 | Mean error from "a" to "t" − 3·888. |
| g | 61·00 | 9·225 | 2·665 | 2·529 | − 5·10 | |
| h | 54·25 | 10·89 | 2·447 | 2·307 | − 5·72 | |
| i | 53·75 | 12·94 | 2·222 | 2·101 | − 5·44 | |
| j | 61·00 | 14·72 | 2·083 | 1·959 | − 5·95 | |
| k | 53·50 | 16·67 | 1·935 | 1·820 | − 5·95 | |
| l | ,, | 20·18 | 1·651 | 1·637 | − 0·84 | |
| m | ,, | 23·06 | 1·587 | 1·521 | − 4·20 | |
| n | 53·25 | 27·41 | 1·465 | 1·381 | − 5·73 | |
| o | 61·00 | 28·38 | 1·383 | 1·356 | − 1·97 | |
| p | 53·25 | 35·81 | 1·227 | 1·192 | − 2·87 | |
| q | 54·50 | 38·19 | 1·199 | 1·149 | − 4·20 | |
| r | 54·50 | 52·36 | 1·006 | 0·964 | − 4·20 | |
| s | ,, | 60·11 | 0·887 | 0·894 | + 0·78 | |
| t | ,, | 70·79 | 0·863 | 0·817 | − 5·3 | |
| u | ,, | 81·66 | 0·837 | 0·754 | − 9·97 | Near critical point. |
| v | ,, | 93·97 | 0·785 | 0·699 | −10·96 | |
| w | ,, | 121·0 | 0·726 | 0·605 | −13·90 | |
| x | ,, | 125·0 | 0·703 | 0·594 | −15·50 | |
| y | ,, | 129·4 | 0·696 | 0·584 | −16·18 | |
| z | ,, | 145·2 | 0·693 | 0·547 | −21·07 | |
| $a_1$ | ,, | 191·8 | 0·683 | 0·468 | −23·64 | |
| $b_1$ | ,, | 217·2 | 0·632 | 0·437 | −30·00 | |
| $c_1$ | ,, | 330·3 | 0·322 | 0·346 | + 7·60 | |
| $d_1$ | ,, | 396·2 | 0·280 | 0·320 | +14·16 | |
| $e_1$ | ,, | 434·5 | 0·259 | 0·298 | +14·76 | |
| $f_1$ | ,, | 476·4 | 0·213 | 0·283 | +32·92 | |
| $g_1$ | ,, | 602·5 | 0·242 | 0·258 | +33·94 | |

TABLE No. 2.

Rivetted sheet iron pipes $n = 1·825$, $c = 0·005674$, $x = 0·677$

| Reference number. | Diameter in ft. | S. | Velocity in ft. per second. Observed. | Velocity in ft. per second. By formula | Error per cent. | Name of observer. |
|---|---|---|---|---|---|---|
| 340 | 0·911 | 30·22 | 10·021 | 9·993 | −0·31 | Hamilton Smith. |
| 341 | ,, | 39·08 | 8·659 | 8·685 | +0·30 | ,, |
| 342 | ,, | 59·00 | 6·927 | 6·932 | +0·07 | ,, |
| 343 | ,, | 74·96 | 6·094 | 6·078 | −0·26 | ,, |
| 344 | ,, | 117·64 | 4·712 | 4·748 | +0·77 | ,, |
| | | | | Mean | +0·112 | |
| 345 | 1·056 | 30·14 | 10·706 | 11·064 | +3·30 | ,, |
| 346 | ,, | 45·066 | 8·646 | 8·877 | +3·30 | ,, |
| 347 | ,, | 70·03 | 6·962 | 6·973 | +0·15 | ,, |
| 348 | ,, | 149·70 | 4·595 | 4·599 | +0·07 | ,, |
| | | | | Mean | +1·68 | |
| 349 | 1·23 | 30·95 | 12·090 | 12·246 | +1·20 | ,, |
| 350 | ,, | 40·49 | 10·593 | 10·438 | −1·47 | ,, |
| 351 | ,, | 60·75 | 8·462 | 8·356 | −1·27 | ,, |
| 352 | ,, | 81·50 | 7·314 | 7·114 | −2·72 | ,, |
| 353 | ,, | 91·16 | 6·841 | 6·693 | −2·26 | ,, |
| 354 | ,, | 199·21 | 4·383 | 4·359 | −0·54 | ,, |
| | | | | Mean | −1·176 | |
| 286 | 2·43 | 85·32 | 10·78 | 11·0 | +2·0 | ,, |
| | | | | Mean error for four pipes | +0·654 | |

TABLE No. 3.

Open channel, semicircular (4 1.t. diam.) Pure cement $n = 1·74$, $c = 0·004$, $x = 0·67$

| Reference number. | Hydraulic radius in ft. | S. | Velocity in ft. per second. Observed. | Velocity in ft. per second. By formula | Error per cent. | Names of observers. |
|---|---|---|---|---|---|---|
| 223 | ·366 | 192·27 | 3·02 | 3·037 | +0·56 | Darcy and Bazin. |
| 224 | ·503 | ,, | 3·72 | 3·757 | +1·01 | |
| 225 | ·605 | ,, | 4·16 | 4·252 | +2·24 | |
| 226 | ·682 | ,, | 4·60 | 4·607 | +0·17 | |
| 227 | ·750 | ,, | 4·87 | 4·911 | +0·71 | |
| 228 | ·809 | ,, | 5·12 | 5·166 | +0·91 | |
| 229 | ·867 | ,, | 5·29 | 5·412 | +2·32 | |
| 230 | ·915 | ,, | 5·51 | 5·611 | +1·84 | |
| 231 | ·949 | ,, | 5·75 | 5·75 | 0·00 | |
| 232 | ·992 | ,, | 5·91 | 5·92 | +0·25 | |
| 233 | 1·029 | ,, | 6·06 | 6·07 | +0·18 | |
| 234 | 1·034 | ,, | 6·11 | 6·09 | −0·32 | |
| | | | | Mean | +0·82 | |

TABLE No. 4.

Open channel, rectangular (5·94ft. wide) Pure cement $n = 195$, $c = 0·006429$, $x = 0·61$

| Reference number. | Hydraulic radius in ft. | S. | Velocity in ft. per second. Observed. | Velocity in ft. per second. By formula | Error per cent. | Names of observers. |
|---|---|---|---|---|---|---|
| 8 | ·168 | 204·1 | 3·34 | 3·348 | +0·24 | Darcy and Bazin. |
| 9 | ·251 | ,, | 4·39 | 4·376 | −0·29 | |
| 10 | ·322 | ,, | 5·04 | 5·095 | +1·08 | |
| 11 | ·375 | ,, | 5·68 | 5·591 | −1·55 | |
| 12 | ·430 | ,, | 6·08 | 6·078 | −0·04 | |
| 13 | ·474 | ,, | 6·51 | 6·450 | −0·91 | |
| 14 | ·518 | ,, | 6·83 | 6·809 | −0·30 | |
| 15 | ·558 | ,, | 7·12 | 7·125 | +0·09 | |
| 16 | ·595 | ,, | 7·41 | 7·410 | 0·00 | |
| 17 | ·632 | ,, | 7·63 | 7·688 | +0·76 | |
| 18 | ·665 | ,, | 7·86 | 7·930 | +0·78 | |
| 19 | ·696 | ,, | 8·07 | 8·154 | +1·04 | |
| | | | | Mean | +0·075 | |

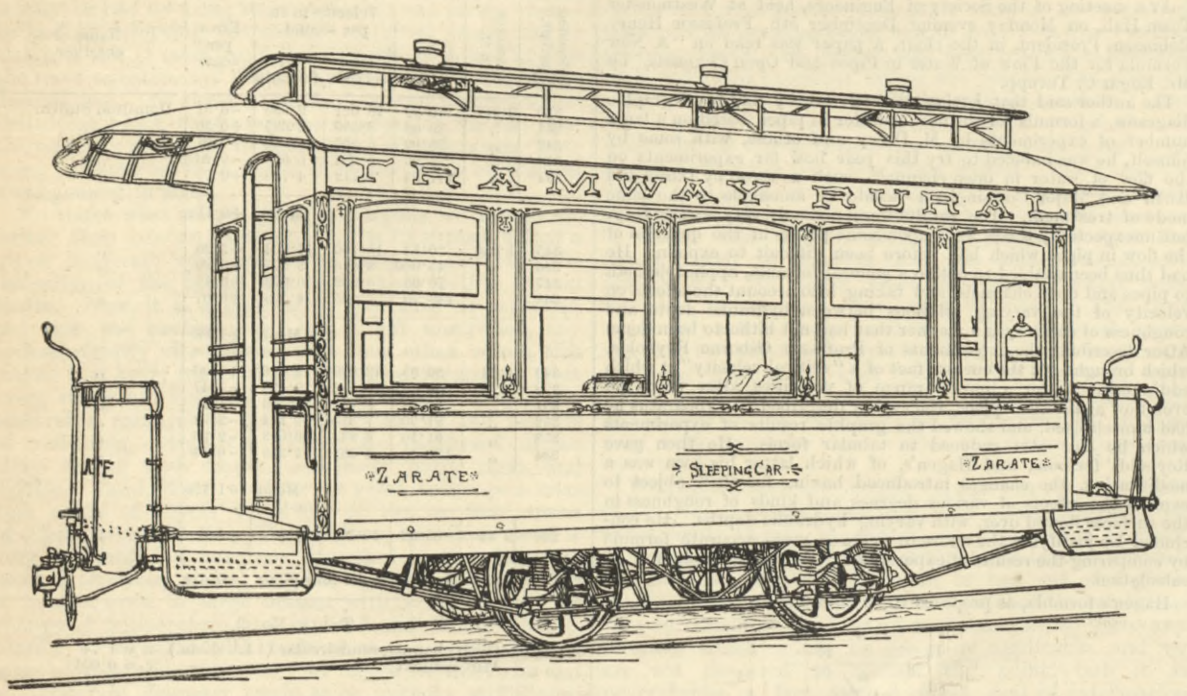
TABLE No. 5.

Open channels "Earth no vegetation," &c. $n = 2·00$, $c = 0·015356$, $x = 0·72$

| Reference number. | Hydraulic radius in ft. | S. | Velocity in ft. per second. Observed. | Velocity in ft. per second. By formula | Error per cent. | Names of observers. |
|---|---|---|---|---|---|---|
| 367 | 0·96 | 4000 | 0·89 | 1·00 | +12·3 | Darcy and Bazin. |
| 368 | 1·32 | 3636 | 1·34 | 1·318 | − 1·5 | ,, |
| 369 | 1·57 | 4066 | 1·36 | 1·410 | + 3·6 | ,, |
| 370 | 1·78 | 3636 | 1·67 | 1·635 | − 2·1 | ,, |
| 7 | 2·871 | 2326 | 2·54 | 2·90 | +14·0 | Baumgarten. |
| Ganges | 4·10 | 4878 | 2·70 | 2·57 | − 4·0 | Cunningham. |
| Canal | 5·00 | 4166 | 3·40 | 3·21 | − 5·5 | ,, |
| "Solani | 6·10 | 4545 | 3·70 | 3·55 | − 4·0 | ,, |
| right" | 8·00 | 5263 | 4·10 | 4·01 | − 2·2 | ,, |
| 478 | 6·721 | 10720 | 2·515 | 2·48 | − 1·3 | Ellet. |
| 472 | 15·706 | 2238 | 3·076 | 3·162 | + 2·7 | Humphreys and Abbot. |
| 473 | 13·039 | 2681 | 2·843 | 2·527 | −11·1 | |
| 474 | 12·801 | 2736 | 2·807 | 2·468 | −12·0 | ,, |
| 475 | 12·470 | 2281 | 2·789 | 2·652 | − 4·9 | ,, |
| Great Nevka | 17·418 | 67250 | 2·0486 | 1·965 | − 4·07 | Destrem. |
| 460 | 72·03 | 48760 | 5·929 | 6·414 | + 8·1 | Humphreys and Abbot. |
| 461 | 72·46 | 58380 | 5·887 | 5·887 | 0·0 | |
| | | | | Mean | − 0·704 | |

STEAM TUG BOAT FOR THE VOLGA.—Notwithstanding the low freights current last navigation on the Volga a great deal of capital continues to be sunk in fresh steamers and barges. One of the more energetic of the Nijni Novgorod steamboat owners, Gordei Chernoff, has commenced building a boat, with engines designed to indicate 2400-horse power, intended to tow up barges laden with masouta, that is naphtha residue, from Astrakhan to Nijni Novgorod. The engines are already commenced, to the designs of V. Kalasknikoff, parts being ordered at several different works. The engines will be triple compound, three cylinders, one 38in., one 54in., and one 80in.; stroke 8ft.; three cranks at 120 deg.; crank shaft, 16½in. in diameter. Four double furnace return tube boilers, fitted to use masouta as fuel, with a total heating surface of 7500 square feet, will be made of Russian ⅝in. plates; working pressure 120 lb.; paddle wheels to be feathering. The hull will have the following dimensions: Breadth, 37ft.; length on water line, 245ft.; depth, 12ft. 6in.; draught with water in boilers and fuel on board, 3ft. 6in.; estimated displacement, 630 tons. The tug ought to tow up the Volga one million poods, that is about 16,500 tons, of masouta in bulk in eight barges at about three miles an hour, against stream.

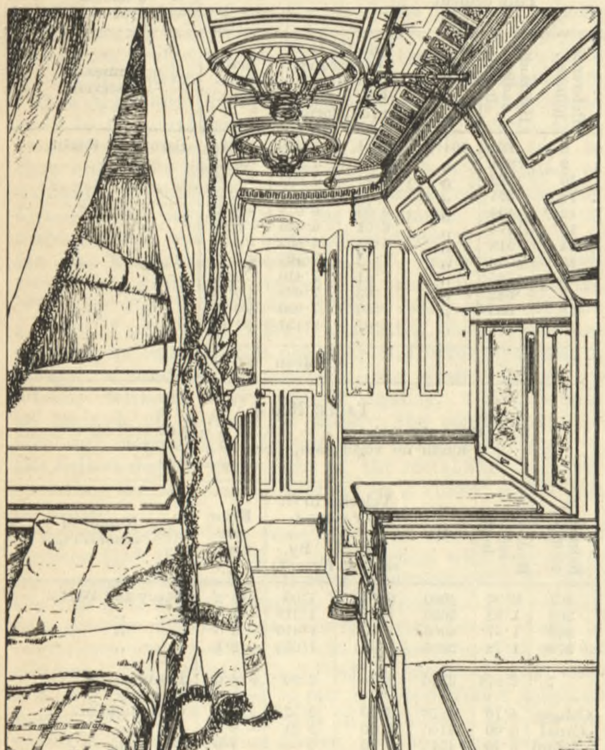
# TRAMWAY SLEEPING CAR.




## A TRAMWAY SLEEPING CAR.

THE illustrations which we give herewith, sent us by our American correspondent, represent a novel departure in rolling stock; namely, a sleeping car for a tramway.

The line is in South America, in the Argentine Republic, running east and west of Buenos Ayres, and connecting that city with a number of outlying towns. The length of the line is about 250 miles, and its route is along the course of the Rio Parana to Zarate. The grades are very light. Horse traction is employed for the reason that while coal costs about 11 dols. per ton, a good horse can be purchased for 20 dols., while another 20 dols. will nearly cover the expense of keeping him for a year. The horses are changed frequently during the trip. The entire trip occupies about three days, and the fare is 50 dols. The road is owned by a company headed by a resident of Buenos Ayres, and it is understood to have been equipped by English capital.



The sleeping cars are 18ft. long over the body, and 8ft. wide. They have four upper and four lower berths, adapted for one occupant each, although two slim persons could sleep in them with comfort. The arrangement of the berths, and the general interior arrangement of the car, is similar to that adopted for railroad sleeping cars in the United States. The interior is handsomely finished in carved mahogany and upholstered with fine plush cushions; the faces of the upper berths are panelled and decorated with inlaid woodwork. During the day, tables for lunch, cards, &c., can be placed between the seats, and are set in a little closet at one end when not in use. A passage-way of convenient width runs longitudinally between the seats.

At one end of the car is a water-closet, with hopper and urinal. A very small stove is provided, and is placed in a fireproof alcove extending into the water-closet. The car is provided with a toilet room, fitted with a marble-top wash-basin, nickel-plated pump, and a large tank underneath the wash-stand; the toilet room has also a linen closet, a closet for a blacking-box, &c., and a water cooler. The car is lighted at night with three centre lamps. The deck lights have small squares of moulded and tinted glass, and the sashes below are glazed with polished plate glass. A Brussels carpet covers the whole floor of the sleeping compartment, which is separated from the toilet room, or saloon, by a double-hinged door.

In the interior view, the right-hand side of the car is shown as arranged for the daytime, with the seats and tables in place and the upper berths shut up against the roof; while on the left-hand side the berths are let down, the curtains rigged, and the beds made up for the night. The cars were boxed whole for shipping, except that the sub-sills, running gear, and platforms were taken off and shipped in separate packages.

The cars were built this year by the J. G. Brill Company, of Philadelphia, Pa., who have also sent out a large amount of other equipment, including passenger, freight, and refrigerator cars, two derrick cars, and some hearse cars for funeral trains. The above illustrations are made from tracings of photographs.

## McLAREN'S PATENT HIGH-SPEED ROAD LOCOMOTIVE.

THE engine we illustrate this week on page 496 is one of several constructed by Messrs. J. and H. McLaren for the *Fourgon poste* service in the South of France. This service is in the hands of different contractors, and altogether apart from the postal service of the State. It consists of the collection and delivery of parcels and light merchandise in districts remote from railways or indifferently served by them. Strange as it may appear, many of the largest railway centres are also the chief centres of the *Fourgon poste* services, which collect their parcels in one town and convey them by horse conveyance, and deliver them in another town many miles away, although there may be a direct line of railway between the two places. The excessive charges of the railways for goods carried *grand vitesse*, and the excessive time occupied in the conveyance and delivery of goods carried at *petite vitesse* rates, enables these contractors or carting agents to do a large business, many of them requiring several hundreds of horses for their work. Some two years ago Messrs. McLaren made one of their compound road locomotives, and tried it on one of the principal *Fourgon poste* lines with so much success that in a short time a number more was ordered, similar to that engraved. The engines are on the compound system, 12-horse power, working with an average pressure of 175 lb. on the square inch. They are mounted on two laminated locomotive springs under each axle. They are running regularly between two large towns in the South of France, seventy miles apart. The goods are collected and packed in the wagon—which will carry about six tons—during the day and despatched every evening. Consequently the whole of the running is done in the night. Twelve hours are allowed for the journey of seventy miles, but out of this about three hours must be deducted for stoppages at various places *en route* to take up and put down merchandise. The average running speed is therefore about eight miles per hour. The road for about thirty miles of its entire length is fairly straight and through a comparatively level country; for the remaining forty miles it is very hilly, the gradients varying up to as much as 1 in 11, while some are as much as three to four miles long. For miles the road winds along a shelving side of the mountains without any protection whatever on the low side, while at another part it descends a zigzag course down to the bottom of a very steep valley. In consequence of the dangerous nature of the road it is of the greatest consequence that the engines should be fitted with ample brake-power and an efficient system of lighting. They are therefore fitted with a steam brake—worked by McLaren's patent steam reducing valve—as well as the ordinary hand brake. The former can be applied instantly with such force as to pull the engine up with full steam on, and at the same time, by means of a chain, the brake is also applied to the wheels of the wagon. In the experimental engine it was found impossible to make lamps which could be relied upon, so the new engines have all been fitted with an arrangement for burning ordinary gas. This is compressed into a receiver up to 175 lb. pressure, and reduced down to burning pressure by means of a patent regulator or diminishing valve, which Messrs. McLaren specially designed for this purpose. One charging of gas is sufficient to give a brilliant head-light and supply the signal lights for the round trip of 140 miles. The water tank capacity is sufficient for twenty-five miles, so that, with a fill-up before starting, it is only necessary to take up water twice *en route*. When the roads are in fair condition, 10 cwt. of fuel suffices for the round journey—a little more is required in bad weather. The weight of the engine empty is 13½ tons; loaded up with coal and water, 15 tons; the wagon weighs 2½ tons, and the load from 5 tons to 7 tons, so that the average total weight of the train is about 23 tons. The service is a daily one from each end, so that one engine leaves each terminus each evening with its load and goes straight through with it. A reserve of engine-power is always available, so that ample opportunities exist for washing out, cleaning, and repairs. The average mileage of each engine is about 15,000 miles per annum. The engines in question have been running for over six months without a hitch or breakdown, and the system is admitted by all to be a complete success.

MANCHESTER SHIP CANAL.—Seven hundred men are now at work on the Manchester Ship Canal, and the contractors expect shortly to employ two thousand. The steam navvies are causing much interest, and a light railway has been laid between Bromborough and Ellesmere Port.

## ELECTRIC LIGHTING FROM CENTRAL STATIONS.

AT the last meeting of the Manchester Association of Engineers a paper on "Electric Lighting from Central Stations" was read by Mr. J. R. Williamson, of the Swan-Edison Electric Light Company. The following gives the greater part of the paper:—

In this country, up to the present time, with very few exceptions, electric lighting has taken the form of isolated or separate installations. There are, of course, and will continue to be, many cases where the only means of having this illuminant will be in this way; and for large works, where it is necessary to carry on processes night and day, the saving over any other method of lighting is a very substantial one. Even in cotton mills, where not more than 300 to 400 hours of artificial lighting is required per annum, it has been found to be economical. Hence, a short description of such an installation will probably not be out of place here.

We have, first of all, the motive power, which may be a steam, gas, petroleum, or hot-air engine, or where there is water-power, a turbine. We need not dwell on this point beyond saying that steadiness in the driving is of vital importance, and therefore the mill or works engine should only be used in such cases where there is not a variation of more than say 2 per cent. either way. Next we have the dynamo. After the motive power and the dynamo, we have the main conductors and the arrangements for distributing the current, and using it in lamps throughout the building. The sectional area of all wires should be sufficient to carry double the amount of current ordinarily required, without perceptible heating; the copper should be very carefully insulated with prepared cotton, and india-rubber, with a strong outer braided covering, and further where likely to be interfered with, should be encased with woodwork.

There are a number of very important details, such as the proper arrangement of switches, and safety fuses, which it is not necessary for me to refer to at greater length. I do not wish to disguise the fact that it is possible to cause fire by electricity, but if work is properly carried out and with reasonable precautions, the chances of a fire are much more remote than with any other system of artificial lighting. This is borne out by the attitude of the insurance companies. Water is the principal agent of danger in electric light installations, for if there is any defective insulation and the wires become wet, a connection is thus established with the ground; and if this takes place on both of the leading wires, a "short circuit" and leakage from one to the other is produced, which might cause the heating of some poor conducting material which happened to intervene, and unless there are adequate safety appliances danger might result.

To light a series of buildings on the system just described would involve conductors of such weight and expense as to render the cost prohibitive in competition with gas, except for very limited areas. Under given conditions, it is not a difficult question to calculate what sized mains should be used to give the most economical results. On the one hand we have interest and depreciation

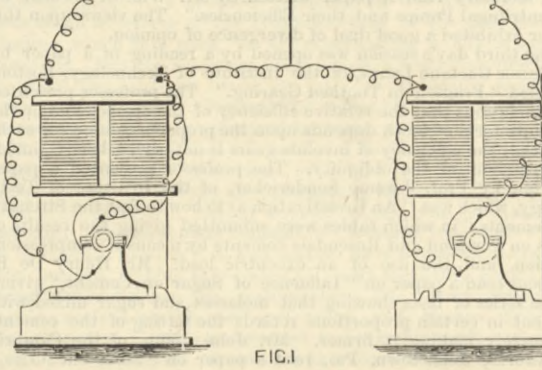


FIG. 1

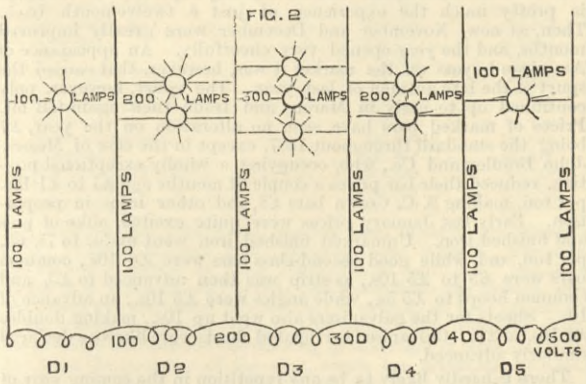
on the outlay, and on the other the cost of the energy lost in the conductors, and the calculation is simply to strike a balance between these, keeping as a minimum such a sectional area as will safely carry the current required. So far we have only considered what is known as the ordinary parallel system of working. Here we have two main conductors, and each lamp forms as it were a bridge from one to the other.

Assuming the electrical pressure, or difference of potential, to be kept constant, then the flow of current is in proportion to the number of lamps in use, and each lamp is entirely independent of its neighbour. Now it will be clearly seen that if we were to arrange two of these lamps in series, and then these pairs in parallel, the amount of current required would be one-half of what it was before. Of course, the electrical pressure would be double, and therefore there would be no real saving of energy; but from the fact that we have reduced the current by one-half, the sectional area of the conductors may also be reduced by one-half to give the same loss as before; but as this loss would be on a higher electrical pressure, the percentage would be less in proportion, and therefore we may still further reduce the size of the conductors. In other words, by arranging the lamps two in series as just described, the conductors would only require to be one-fourth of the weight that would be needed in the previous case for the same loss in transmission. The drawback, of course, would be that to switch out any one lamp would mean that the pair would be turned out. If now we connect the wires between the pairs together by a dummy wire, then turning one lamp out would not extinguish both; but if a number were turned out on the one side, the whole of the current passing through those on the other side would have to pass through the remaining lamps on the first, which latter would be thereby rendered very brilliant, while the former would be much below their nominal candle-power. This arrangement, therefore, would not do in actual work. To get over this difficulty we have the "three wire system," Fig. 1, of Hopkinson and Edison. Two dynamos are connected together, a main wire running from each of their two extreme terminals, and the third wire from the branch connecting the two machines, the lamps being arranged as shown. If now a lamp be extinguished, or a series of lamps on either side, the remaining lamps and those on the other side are not affected. Still this, although an improvement on the simple parallel plan, is not sufficient, and could only be adopted with economy for installations where the furthest lamps are within a distance of 500 yards, and therefore for areas which would have, say, 10,000 lamps within such a radius; then, in such a densely populated part, the cost of a central station would be almost prohibitive. We may extend this system, until we have an arrangement in which there are five dynamos connected together, Fig. 2, but this arrangement has many objections and difficulties.

It is evident, and has long been known, that the only way in which distribution over large areas could be effected would be to work with a high electro-motive force, and thereby for a given amount of energy have a small current; but it has not been found practicable to construct incandescent lamps of a greater resistance than 200 ohms. To increase their resistance means the use of a longer and thinner filament, which is much more liable to get broken, and will not endure the passage of the electrical current sufficiently long to render them economical; and therefore we are practically limited at the present time to about 100 volts. Efforts have been made to work incandescent lamps in series, using low resistance lamps. The Bernstein Company have made some installations on this system, which, I fear, will not be widely adopted.

About four years ago a system of distribution for public lighting was attempted at Colchester, which should have been more successful than it was. Brush dynamos were used which are capable of giving a constant current and a very high electro-motive force. This current was sent through distributing mains laid under the streets, and a good deal of their trouble was through the inefficient manner in which these mains were insulated. At various intervals sets of accumulators were introduced in these circuits. These accumulators were charged from the central station, and the energy thereby stored distributed to the lamps. They had several

FIG. 2




ingenious arrangements, some of which acted, and some of which did not; among the latter may be mentioned their "Master Cell," which was intended to control the set of which it was one, by breaking the circuit when the charging of the set was completed, and re-establishing it as soon as the cells had run down to a point at which it was desirable they should be again charged. It is a very difficult matter to completely insulate a set of accumulators from the ground, and therefore if a high tension current is being used for charging, there is a great tendency to leakage; and further, this tendency introduces an element of danger, from the fact that all the wires in any private house being in connection with the accumulators, are at the same time in connection with the high tension mains. Hence this system, although a very decided advance at the time, did not live very long. There is another plan, however, which it seems remarkable should have been so slow in developing, especially as it embodies a simplicity which no other previously proposed possesses.

Fig. 3.

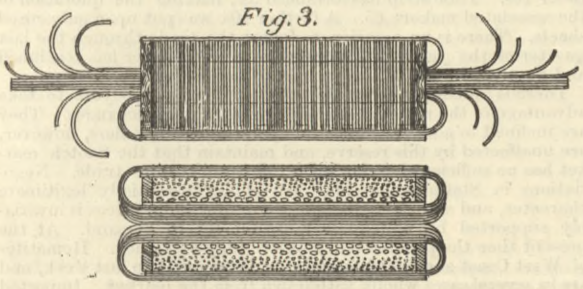
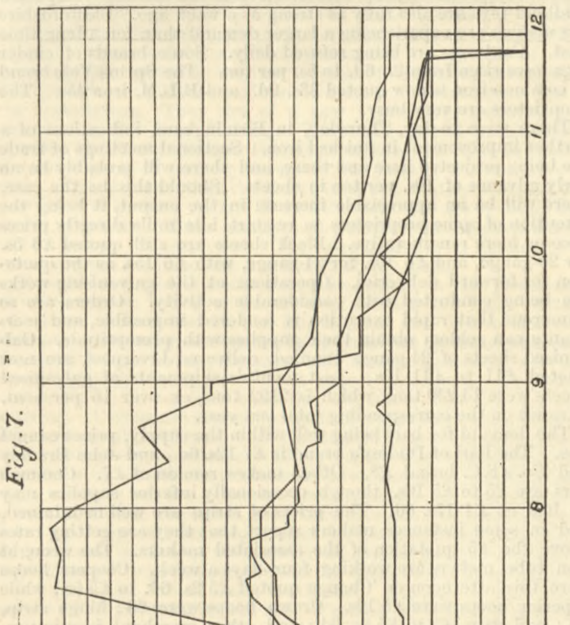
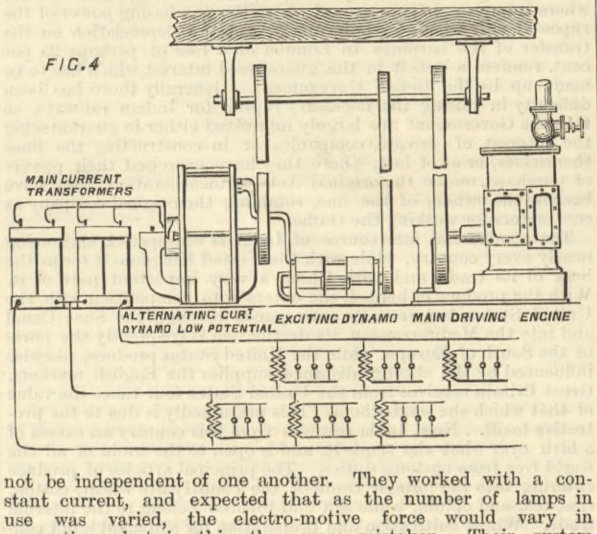


Fig. 7.



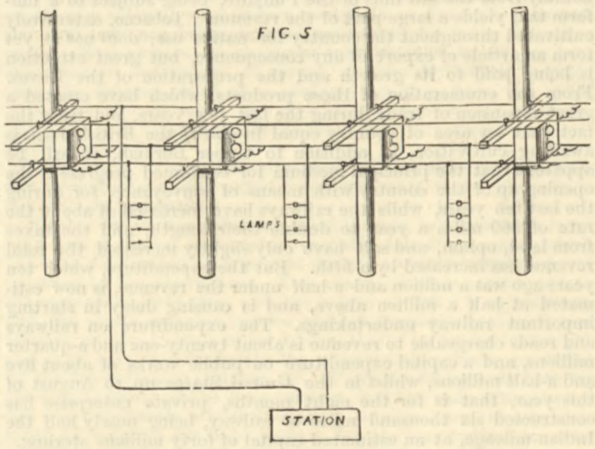

In 1842 Ruhmkorff invented the induction coil which has since borne his name. It consists of a central core, which is simply a bundle of iron wire. On this is wound a short length of thick insulated copper wire, forming the primary coil; and again over this is wound a considerable length of very fine insulated copper wire, forming the secondary coil. On a low-tension quantity current being sent through the primary coil, a very small high-tension current is induced in the secondary, and the instant that the current in the primary ceases or is cut off, an equal and opposite high-tension current is again induced in the secondary. This induced current is instantaneous. The principle of this was known to Faraday, and described by him in 1835. In order to keep it up, it is necessary to use a contact breaker in the primary circuit, to quickly make and break the flow of the current, or a commutator to produce rapid alternations. If, now, we connect the secondary coil of this apparatus with the secondary coil in a similar arrangement, the high-tension alternating current which we have produced will in its turn induce a low-tension current in the thick wire of the second induction coil. Hence if we produce a high tension current, either directly from a dynamo or by the agency of an induction coil, it can be transmitted to a distance, and there converted into a low tension current for use in the lamps at our command; and transmitting it in this manner will require a very small conductor, compared with what would be needed without this induction arrangement. In 1856 Cromwell Fleetwood Varley patented two forms of induction coils, Fig. 3, which are substantially the same as the latest and best converters or transformers, as such coils are now termed. In this coil we have a bundle of iron wires as the core; these wires project beyond the coil, and are doubled over and united round about it, so as to enclose the coil in a sheathing of iron. By this means the magnetic circuit is completed through iron, and not through the air, as in Ruhmkorff's. This is a very important difference. In 1877 a patent was granted to Jablochkoff, which was followed in 1878 by the patents of Edwards and Normanby, J. B. Fuller, Bright, and De Meritens, and further in 1883 by Gaulard and Gibbs' patents. These are all on the same lines, but very little was done until 1883, when Gaulard and Gibbs brought theirs prominently before the public, and in fact lighted up several stations on the underground railway by means of their induction coils, which they called secondary generators. These are connected in series, as shown in diagram No. 9, and so far as transmitting energy was concerned, were successful, but with this arrangement it was not possible to distribute electricity. By this I mean that a system of lighting could be carried out, but the lamps would

FIG. 4




not be independent of one another. They worked with a constant current, and expected that as the number of lamps in use was varied, the electro-motive force would vary in proportion; but in this they were mistaken. Their system embraced—(1) A dynamo producing an alternating positive and negative current of high potential. (2) A secondary generator or converter, which was in fact a Ruhmkorff coil reversed. (3) The secondary circuits, in which the lamps were placed. In October, 1882, Edison took out a patent for "rotating transformers." These were, in fact, a combination of a dynamo and a motor. His idea was to generate a high-tension current at the central station, and transmit this through small conductors to distributing stations, where the current was to be made to actuate a motor, which had in combination with it a dynamo, the latter producing a low-tension current, which was supplied to the lamps. These "rotating transformers" were placed in series in the primary circuit, the lamps being of course in parallel, in the secondary. Finding that this arrangement did not work in the manner he expected, he took out a patent a year later for rotating trans-

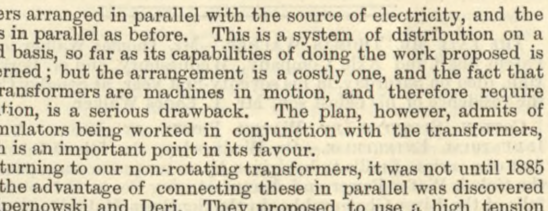
FIG. 5




formers arranged in parallel with the source of electricity, and the lamps in parallel as before. This is a system of distribution on a sound basis, so far as its capabilities of doing the work proposed is concerned; but the arrangement is a costly one, and the fact that the transformers are machines in motion, and therefore require attention, is a serious drawback. The plan, however, admits of accumulators being worked in conjunction with the transformers, which is an important point in its favour.

Returning to our non-rotating transformers, it was not until 1885 that the advantage of connecting these in parallel was discovered by Zipernowski and Deri. They proposed to use a high tension alternating current dynamo, feeding into a pair of main conductors. The primary coil of each converter being connected across these mains in exactly the same way as the incandescent lamps are con-

FIG. 6



nected across the mains of the secondary circuits. Of course in this case the primary coil has a long thin wire, and the secondary coil a short and thick one. The relative length of these two wires, independent of their thickness, is determined by the conversion which it is desired to make. For example, if the difference in potential in the mains is 1000 volts, and the lamps in the secondary circuit are of 50 volts, then the ratio is 20 to 1; that is, the primary wire must have 20 times the length of the secondary wire, and as the latter will have induced in it almost 20 times the quantity of current, it must have a sectional area of 20 times that of the primary. This decides the relative lengths only, and the question to decide the actual length of either still remains. This is determined by the magnetic induction of the transformer, of whatever type may be under consideration, according to the electro-motive force and number of alternations per second of the primary current to be used, and it should be such that when the secondary circuit is open, that is when there are no lamps in use, the amount of current flowing through the primary is practically nil. At first sight it may appear that to obtain this it would require a very great length of primary wire, but this is not so, on account of the magnetic induction which, owing to the current being an alternating one, continually produces an opposing electro-motive force. This is extremely important, as the converters whether in use or not, are always in the circuit. It is perfectly possible to construct apparatus on these lines, so that there shall not be a loss of more than 2 per cent. or 3 per cent. either when lamps are in use or not. Further, so long as the difference of potential in the mains is kept constant, which can be easily done, the amount of current passing is strictly in proportion to the number of lamps in use, and the potential in the secondary circuit being also constant, every lamp is independent of the remainder, and the action of one converter is absolutely independent of the others. Hence you will see that this as a system of distribution leaves little to be desired. Apart from the lamps being independent of one another, the current in the mains, and consequently the coal consumed at the central station, is proportionate to the number of lamps in actual use, and hence the system is an economical one to work. The construction of Zipernowski's transformer or converter is the essence of simplicity. It consists of forming two insulated conductors—a primary and secondary respectively—into a core of ring form, and then overwinding them with iron wire. The only difference between this and what we have already mentioned is that the wire is inside and the iron outside instead of the reverse. This iron also forms a complete magnetic circuit, which there is not in the secondary generator of Gaulard and Gibbs. The only drawback is, that in case of a slight fault inside, it is necessary to undo the whole of the iron sheathing in order to get at it. On the other hand, as the wires are so well protected, there is less liability to damage. In the same year—1885—Ferranti patented a transformer, in which the core consists of hoop iron, on which the two coils are wound, and then the iron is bent over and the ends joined, thus enclosing the coils. The whole arrangement is then encased in a cast iron box. This, you will see, is a very similar arrangement to Varley's patent, taken out in 1856.

The dynamos used with these converters, as already mentioned, are high tension alternating current machines. In a machine constructed by Messrs. Elwell-Parker of Wolverhampton, for this purpose, the armature consists of a soft iron wheel, carried on a steel shaft by suitable supports, and having wound upon it a considerable number of coils of wire. These coils are passed rapidly before the poles of fixed electro magnets, which alternate in polarity. The current is collected from two insulated rings by rubbing contact pieces. A small continuous current dynamo is, of course, required to excite the field magnets. Instead of using such a dynamo, Rankin Kennedy makes use of a low potential alternating current dynamo, in conjunction with main transformers, to produce the high tension current, as seen in Fig. 4; this is then made use of in the manner already described.

The Westinghouse Company, who are the owners of Goulard and Gibbs' American patents, have within the last year been energetically at work. Although they are working under the patents just referred to, the converters they used are very similar to Ferranti's; in fact, the best construction is so simple that very little variety is possible. They use an electro-motive force of 1000 volts in the main circuits and 50 volts in the lamp circuits. They carry the wires on poles overhead, Fig. 5, to which poles the converters are also attached, and the lower wires on the diagram represent the secondary circuit, from which branches are taken into the buildings to be lighted. Their machines are constructed in three sizes, and the exciters only absorb 2 per cent. of the total energy. The converters are made in several sizes, and weigh approximately 3 lb. per lamp; the efficiency is given at 95 per cent. There are already twenty-seven electric light stations at work in the States on this system.

The Grosvenor Gallery installation, commenced by Sir Coutts Lindsay and Co., under the management of Mr. Ferranti, was the first in this country—I mean, of course, on the parallel system of converters. Siemens' alternating current dynamos and Ferranti's converters, connected by circuits run overhead, are used, and a very considerable number of lamps is nightly supplied from this plant. There is another at Eastbourne, which I think is a better example of public lighting, although as yet nothing like so extensive. In this installation an Elwell-Parker alternating current dynamo and Lowrie and Hall converters are used. The mains are run underground, and branches tapped on where required. Fig. 7 gives some interesting curves, showing the output of their dynamo, at different periods of the night's run, for four consecutive nights. As they work at 2000 volts, each ampère generated by the dynamo would be capable of supplying thirty lamps in the secondary circuits. They have an ingenious arrangement for maintaining the constant electro-motive force of the dynamo. So far I have not referred to arc lamps, because in the question of public supply of electricity, they will in all probability play a minor part. High candle-power incandescent lamps would, it seems to me, be more suitable in the majority of cases; at the same time it is satisfactory to find that it is possible to work arc lamps from converters, and thus we would have the same dynamos supplying both arc and incandescent lamps, without any risk of the one interfering with the other.

The question of meters is a very important one in connection with the public supply of electricity. Professor Forbes brought one before the meeting of the British Association in Manchester, in September last, which promises to be of good service. It consists of a short length of thick platinum wire arranged in spiral form, through which the current is caused to pass. This wire heats in proportion to the amount of current passing, and the heat causes convection currents in the air surrounding the spiral, which again rotate a small fan, and the number of turns is registered by clockwork. There are some other meters, but time will not permit of a description.

When electric lighting first came before the public, there was a great rush, and a large number of companies was floated. The public expected too much, and their speculation only brought disappointment. This was a serious blow to the industry, which is only now regaining the confidence of which it was robbed by speculators. During the last five or six years, electricians and engineers have been at work, and I have endeavoured to give you in some measure an account of the results of their labours. Great scientific difficulties have been swept aside, but there still remains a difficulty of another kind, which has been a serious impediment to the progress of central station lighting in this country. I refer to the Electric Lighting Act of 1882, which contains restrictions under which no private company could work.

The Eastbourne Company obtained their right to run underground conductors from the Corporation, prior to the passing of this Act. Hence they are in a position which I believe is unique. The Act does not refer to overhead conductors, and therefore, where the necessary permission can be obtained, work might be carried out on these lines. Still, there are some serious drawbacks, and altogether such a plan is not a satisfactory one. There have been already three or four Bills before Parliament to amend the 1882 Act, but nothing has as yet been done; still, it is quite certain that public interest will very soon demand the consideration of this point. All that electrical companies desire, is to be placed on an equal footing with the gas companies, with whom they do not fight shy of competition, but are anxious for it.

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THE EXTENDED ELECTRO-METAL EXTRACTING, REFINING, AND PLATING COMPANY, LIMITED.—Under this title a company is being formed to acquire and work the business and patented electro processes for the United Kingdom of the Electro-metal Extracting, Refining, and Plating Company, for refining, separating, and recovering tin, copper, and other metals and alloys from scrap and old metals, dross, slags, and mining tailings, and for electro-galvanising iron goods. The capital is £150,000, in £1 shares. A good board of directors has been formed. Mr. Thos. Fenwick will take the post of managing director

## WOEHLER'S EXPERIMENTS ON TIRE TESTING.

HERR A. WOEHLER, well known for his experiments on the fatigue of metals and his law deduced from them, has communicated to the *Centralblatt der Bauverwaltung* the results of some interesting experiments on the comparative value of the drop and the tensile tests for wheel tires, which were substantially as follows:—Ten steel tires, all out of one charge of iron, were experimented upon, of which the first two were treated by the drop test, and were called Nos. 1 and 2. No. 1 had run 61,605 miles, and broke into four pieces at the first drop of a 990 lb. tup falling 9ft. 10in. The four pieces were heated, straightened, and cut into test specimens, which showed high and very uniform tensile strength and contraction of cross-section in the four cases of 44·5, 13·3, 59·5, and 61·2 per cent. No. 2, with a record of 60,338 miles, failed to break with a drop height of 1ft. 8in., but broke into two pieces at the second drop from a height of 6ft. 7in. The remaining eight tires were tested by a method in use on the Western Railroad of France for all wheels coming into the shop to be turned up, before that operation is undertaken. The eight tires in position on the wheels were struck with a 15 lb. sledge at various points on their circumference. Of these, one with a record of 60,338 miles broke at the 28th blow; another, having run 37,287 miles, broke at the 11th blow. The remaining six, with similar records, failed to break, though one received 110 blows, and the remaining five 500 each. The usual test of 50 blows was much exceeded, in order to show that good tires were not damaged by the usual test. Since two of the tires broke under 11 and 28 blows respectively, it was inferred that the test was more severe than ordinary traffic use, which does not seem from this test alone quite proven, since the tires, after long use, may have been near the breaking point.

With a truly scientific spirit of investigation, however, Herr Woehler proceeded to check up the effect of his hammer blows by the result of a similar test on rails. This was accomplished by using a tilt hammer of equal mechanical effect to that of the hammer used against the tires, with a head similar in form and dimensions to that of the tread of the tires. With this the end of a puddled steel rail was hammered in a manner as much as possible resembling the action of a rolling wheel. The result was the practical destruction of the rail end under one-sixth the number of blows which would be received by it in ordinary traffic in one year; a conclusive confirmation of the deduction that the hammer test itself was a very severe one, and as the hammer test had only one-thirtieth of the mechanical effect of the drop test, the inference was plain that a tire might be perfectly capable of safe traffic usage, although incapable of standing the usual drop test.

It was found, furthermore, that whereas unannealed pieces of the broken tire could not be straightened cold under the hammer without breaking, after annealing this could be done easily without injury to the steel, showing that the brittleness was due to the hardness caused by rolling. Finally, to see whether the reheating of the first test pieces had not improved the quality of the steel, a test piece was cut out of one of the fragments of broken tire, and the result in the testing machine, while showing a little less ultimate strength, indicated equal toughness with the first sections, as shown by the contraction of section before rupture. In order to ascertain the boundaries of the roll-hardness within the body of the tire, a broken piece of tire was cut into three curved rails, all out of the tread, the first containing the side of the tire away from the flange, and bounded top and bottom by the tread and inner surface of the tire, the second bounded as in the first on top and bottom, but with freshly cut sides, while the third piece was similar to the second, except that about $\frac{3}{8}$in. was turned off the top and bottom, leaving none of the original bounding surfaces of the tire. These test pieces were all set up with the convexity upward, bearing on their ends, and were struck with a hammer.

The first was bent $\frac{7}{16}$in. below a straight line without injury; the second broke after bending an estimated amount of $\frac{1}{16}$in.; and the third was deflected to nearly 1in. below the horizontal without damage. It was therefore assumed that the side surfaces of the tire did not experience any roll-hardening, and that the latter did not extend more than $\frac{3}{8}$in. from the outer and inner surfaces, conclusions which do not seem entirely justified, in view of the fact that No. 1, which had the outer and inner surfaces intact, allowed a very extensive deflection and was not bent to rupture; so that it cannot be known how its ultimate deflection would have compared with that of No. 3. In order to see how much impact had to do with the brittleness of the tires under the drop test, one of the broken pieces 13in. long was submitted to hydrostatic pressure at the middle of its length and broke with a sharp clang after deflecting $\frac{1}{8}$in. Annealing of tires, it is suggested, would not be an absolute preventive of brittleness, inasmuch as the hardness produced by the rolls may also arise from the rolling contact with the rails in use; and, one might add, probably also still more from the action of brakes.

The experiments are in any event most interesting and important, and thanks of the railroad world are due to Herr Woehler for the patience with which he has followed up the subject in its various ramifications, and it is to be hoped that he and others on both sides of the water will be able to continue and repeat the investigation with a view to a more substantial foundation for permanent deductions. The experiments put the relative advantages of steel and chilled iron tires into a somewhat altered light by showing that the steel tire is after all not so widely dissimilar in its constitution as to brittleness and strained condition of skin from its chilled iron competitor.—*The Railroad Gazette.*

## RAILWAYS IN INDIA.

AT a recent meeting of the Liverpool Engineering Society, November 16th, the following paper was read by Mr. R. Lethbridge Tapscott, Assoc. M. Inst. C.E., "Dealing with Indian Railway Requirements and Resources."

The arrangement of the railway system of India having been under the supervision of the Government, care has been taken to avoid those competing lines which are so numerous in this country; but while this has been obtained the mileage is small compared to the extent of country. There are consequently many districts far away from the advantages of railway conveyance, while there exist only two routes across the central part of the country. Only one of these forms the connection of the northern system, along the valley of the Ganges from Calcutta on the east and Delhi on the west, to the system occupying the southern part of the peninsula. A large district comprising portions of the provinces of Bengal, Madras, and the Central, is untouched by the present lines, though the Bengal-Nagpur will reach some parts of it. In the western part of the country, and extending to the Indus Valley, there is only one line running north and south, and one east and west. An extensive seaboard from the termination of the Bombay, Baroda, and Central Indian Railway in Cutch reaching to Kurrachee, near the western frontier, is also without a line; while beyond the reach of the Punjab lines is the native State of Cashmere. The Brahmapootra river is the great highway of communication with Assam, having some branch railways from it running to the tea plantations, while touching its southern boundary is the newly acquired Burma State, where the Irawaddy has, like the Brahmapootra, supplied the means of conveyance. Now, however, there is a trunk line in course of construction, yet even then there will remain a vast district devoid of railway facility, and consequently undeveloped.

The necessity for economical railway construction has led to the misfortune of differences in gauge, and should there be any great expansion of goods traffic in the future, the want of uniformity will seriously affect the rapid transit of raw material and agricultural produce, which, unlike manufactured goods, will not bear the cost of handling. The remote districts brought into connection with the ports by means of the narrow gauge lines have developed their resources in so marked a degree that the difference of gauge should not be considered. The great disadvantage in the want of uniformity lies in the fact that the narrow gauge lines are not continuous nor confined to one particular locality, but occur at the extremities of the broad gauge, in the further and more isolated districts, thus creating numerous places for the handling of goods, and necessitating isolated rolling stock of engines, carriages, and wagons, which cannot be taken to any other part of the country where a sudden demand might arise.

The main trunk lines, which were the earliest constructed, are of the broad gauge, having a width of 5ft. 6in., whilst the newer ones and those suggested for frontier defence are the narrow or metre gauge. The broad gauge embraces nearly two-thirds of the mileage, while the remainder comprises the metre gauge, and some short lengths of narrower. There are very great advantages with either system, so that when one has been adopted it is matter of regret that any change should be made. The broad gauge affords the opportunity for better design of the engine, the conveyance of greater bulk in shorter trains, and more comfortable carriages for passengers, besides providing space for future improvements; while the narrow gauge rolling stock has the advantage of a centre buffer, is capable of going round sharper curves, and is proportionately lighter in construction, besides the saving in capital expenditure on bridges and tunnels. The capital invested in English railways is five times the amount expended on Indian lines, which are somewhat less in length. They give suitable facilities for goods and passengers, while earning a fair dividend where it appears in rupees, and where the purchasing power of the rupee is still what it was formerly, yet the depreciation on the transfer of the earnings to London at a loss of perhaps 25 per cent. renders a deficit in the guaranteed interest which has to be made up by the Indian Government. Generally there has been difficulty in raising the necessary capital for Indian railways, so that the Government are largely interested either in guaranteeing the interest of private companies or in constructing the lines themselves, or as of late, where they have exercised their powers of purchase, under the original Acts of incorporation, they have become the owners of the line, retaining the original company as contractors for working the traffic.

The commercial intercourse of India is widespread, embracing nearly every country, while with the United Kingdom it forms the bulk of its trade, and with China a very important part of it. With the produce of her soil she enters into competition with the United States, but from its conveyance through the Suez Canal and into the Mediterranean, its destination is frequently the ports of the South of Europe, while the United States produce, likewise influenced by the shorter distance, supplies the English markets. Great Britain receives from the United States four times the value of that which she sends them. This presumedly is due to the protective tariff. Now, India receives from this country an excess of a fifth over what she sends it, and is open to the trade of all the world free from customs duties. The principal articles of produce entering into the foreign trade of the country are wheat, cotton, rice, tea, and opium, while salt and tobacco belong to the internal trade. Wheat cultivation and preparation for shipment is not conducted carefully enough to enable it to successfully compete with American, and while going largely to the Continent, is used for other purposes as well as for flour. Cotton, of a shorter fibre than the American, is extensively cultivated, and the principal part of it is used in the Indian mills, leaving a fourth for foreign markets, of which only a third comes to the English spinners. So successful has this industry become, that China is largely supplied from Bombay, to the detriment of Manchester. Rice grown around the river mouths, forming the principal article of food to a part of the population, yields the Government about three-quarters of a million from its export duty. The cultivation and preparation of tea, forming a very important industry, is principally sent to this country, thus forcing China tea away. Opium, grown only in special districts under Government supervision, and exported to China, is one of the most important sources of revenue. Salt sent from the Cheshire mines and obtained in other ways in India, notably from the salt hills of the Punjaub, being subject to a uniform tax, yields a large part of the revenue. Tobacco, extensively cultivated throughout the country for native use, does not as yet form an article of export of any consequence, but great attention is being paid to its growth and the preparation of the leaves. From the enumeration of these products, which have created a great expansion of trade during the last few years, and from the fact that an area of country equal in size to the British Isles is awaiting cultivation, in addition to Upper Burmah, it will be apparent that the principal medium for continued progress is the opening up of the country with means of conveyance, for during the last ten years, while the railways have increased at about the rate of 560 miles a year to double their length, and the taxes from land, opium, and salt have only slightly increased, the total revenue has increased by a fifth. But the expenditure, which ten years ago was a million and a-half under the revenue, is now estimated at half a million above, and is causing delay in starting important railway undertakings. The expenditure on railways and roads chargeable to revenue is about twenty-one and a-quarter millions, and a capital expenditure on public works of about five and a-half millions, whilst in the United States up to August of this year, that is for the eight months, private enterprise has constructed six thousand miles of railway, being nearly half the Indian mileage, at an estimated capital of forty millions sterling.

THE LATE MR. THOMAS WALKER.—Mr. Thomas Walker, of the Patent Shaft and Axle Company, Wednesbury, and of Berkswell Hall, died on Saturday, in his seventy-first year, at Studley Castle, the residence of his eldest son, Mr. T. Eades Walker.

COTTON SPINNING BY WATER POWER IN INDIA.—A NEW INDUSTRIAL ENTERPRISE.—On Wednesday, the 5th October, the first of a series of mills to be driven by water power was opened by the Gokak Water Power and Manufacturing Co. at the celebrated falls of the River Ghat-prabha, in the Southern Mahratta Country. This mill, which is intended to spin cotton, overlooks the Falls, and has been constructed to hold 22,000 spindles. For the necessary power to drive the mill, water is diverted from the river at the head of the rapids, about half a mile above the Falls, into a channel running parallel with the river, and rushes down the face of the cliff through a perpendicular steel pipe, about 180ft. long, into the turbine house below the Falls, where three turbines of 250-horse power each transmit the power to the mill. The transmission by steel wire ropes is first up to a pier on the southern cliff immediately overlooking the turbines, at a length of 300ft., and thence to the mill, situated 439ft. further south. The extraordinary length and peculiarity of the line of transmission, and the speed attained by the huge pulley wheels, are said to surpass anything of the kind in the world, and the smoothness and ease with which everything works reflects the highest credit on the engineering skill of the eminent suppliers of the turbine machinery, Messrs. Escher Wyss and Co., of Zurich. The mills are fitted with all the latest improvements in spinning machinery by Messrs. Howard and Bullough and others, and are three miles from the new West Deccan Railway, which will shortly be opened. Mr. J. M. Kerr, late of the Chorley Moor Mill, Lancashire, is the manager, and has now sole charge of all the works, but the construction and superintendence of them was carried out by Mr. R. B. Joyner, C.E., executive engineer, Dharwar, whose valuable services were kindly lent by Government. Mr. Ledermann, from Messrs. Escher Wyss and Co., has attended to the erection and starting of the turbines. The Indian agents of the company are Messrs. Ritchie, Steuart, and Co., Bombay. Thousands of natives of every class have been attracted from all parts of the country to see the mill, and have taken the liveliest interest in the working of the machinery, both inside and outside. The introduction of such an important industrial work must eventually prove of immense benefit to this vastly populated district.—*The Times of India.*

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

(*From our own Correspondent.*)

THE year 1887 has now so nearly come to a close that a review of the twelve months is possible. The year has upon the whole been an improvement for the Staffordshire iron trade compared with that of 1886. There had been several spurts which have done much to atone for the quietude during other parts of the year. Production has bulked out quite as well at the mills and forges as for several years past.

The sheet makers especially have had a grand time of it during the year as regards the demands, though prices have been lean. The quietude in the marked bar trade has been the least satisfactory feature of the twelve months.

It is somewhat singular that the existing experience of the trade is pretty much the experience of just a twelvemonth back. Then, as now, November and December were greatly improved months, and the year opened very cheerfully. An appearance of American buyers on the market it was, however, that caused the spurt of the late autumn of last year. The spurt, however, only continued up to early in March, and trade then again fell off. Prices of marked bars have seen no alteration on the year, £7 being the standard throughout 1887, except in the case of Messrs. John Bradley and Co., who, occupying a wholly exceptional position, reduced their bar prices a couple of months ago £1 to £1 10s. per ton, making S. C. Crown bars £8, and other irons in proportion. Early last January prices were quite excited, alike of pigs and finished iron. Unmarked finished iron went up 5s. to 7s. 6d. per ton, and while good second-class bars were £6 10s., common bars were £5 to £5 10s., as strip was then advanced to £5, and common hoops to £5 5s., while angles were £5 10s., an advance of 10s. Sheets for the galvanisers also went up 10s., making doubles £6 15s. to £7. Galvanised corrugated sheets were likewise declared similarly advanced.

There is hardly likely to be any repetition in the coming year of the action which in February last the makers of unmarked iron pursued in declaring an "official" advance of 10s. per ton on bars, hoops, strips, &c. The market refused to respond, but a 7s. 6d. advance, and in some cases 10s. was at that time being actually obtained.

The April quarterly meetings were a considerable contrast upon what had gone before, and sheets were lower by 5s. to 10s. per ton, and other qualities suffered a somewhat similar decline. Common bars were £5; sheets—doubles—£6 7s. 6d. to £6 10s.; and strips, £5 to £5 5s. These prices fell further as the quarter advanced. Before the third quarter of the year came on there was, however, a decided change for the better, and in July prices were again moving upwards. The sheet makers put 5s. on their prices, and the galvanisers put on 10s. August and September added to the improvement, the United States being prominent among the buyers, and at the October quarterly meetings the revived demand was more perceptible all round. Another 5s. was put upon sheets, making doubles £6 10s., and lattens £7 7s. 6d. to £7 10s. Tube strip has advanced 5s., making the quotation of the associated makers £5. A further 10s. was put upon galvanised sheets. There is no occasion to follow the trade through the last quarter of the year. The improvement of October has continued and developed.

There is a little tendency this week among pig buyers to take advantage of the re-action on the Northern pig exchanges. They are inclined to a less eagerness in operating. Pig sellers, however, are unaffected by this reserve, and maintain that the Scotch market has no sufficient bearing upon the Staffordshire trade. Negotiations in Staffordshire pigs are of an essentially legitimate character, and any strengthening there may be in prices is invariably supported by a genuine improvement in demand. At the present time the position of makers is fully sustained. Hematites of West Coast and Welsh brands are stronger than last week, and are in several cases wholly withdrawn from the market. Imported Midland pigs are also fully as strong as a week ago. Staffordshire pig makers are experiencing a larger demand than for a long time past. Contracts are being refused daily. Some brands of cinder pigs have risen from 2s. 6d. to 5s. per ton. The Spring Vale brand of common iron is now quoted 33s. 9d., and B.L.M. iron 45s. The proprietors are very busy.

There were to-day, Thursday, in Birmingham, indications of a further improvement in finished iron. Sectional meetings of trade are being projected here and there, and there will probably be an early advance of 10s. per ton in sheets. Should this be the case, there will be an appreciable increase in the output, it being the intention of some proprietors to re-start idle mills directly prices become more remunerative. Black sheets are still quoted £6 5s. for 20-gauge, and £6 10s. for 24-gauge, with £6 15s. as the quotation for forward deliveries. Operations at the galvanising works are being conducted with considerable activity. Orders are so numerous that rapid execution is rendered impossible, and merchants can seldom obtain their supplies with promptitude. Galvanised sheets of 24-gauge bundled, delivered Liverpool, are now quoted £11 to £11 10s. Last month's shipments of galvanised sheets were 13,230 tons, which is 2192 tons, or over 16 per cent. advance on the corresponding total last year.

The demand for bars being well within the supply, prices cannot rise. The Earl of Dudley's brand is £7 12s. 6d., and John Bradley and Co.'s S.C. brand £8. Other makes remain at £7. Common bars are £5 to £5 10s., though occasionally inferior supplies may be had at £4 17s. 6d. The prices of strips are well maintained, and in some instances makers report that they are getting rates above the £5 quotation of the associated makers. The wrought iron tube makers are working four days a week. Coopers' hoops were this afternoon on 'Change quoted £5 2s. 6d. to £5 5s., while superior hoops were £5 10s. Crown hoops were £6; hinge strip, £6; nail strip, £5 to £5 2s. 6d.; and other merchant iron in proportion. Puddled iron billets were quoted £3 17s. 6d. to £4 per ton.

The Staffordshire Steel and Ingot Iron Company is producing larger quantities of metal from its basic and Batho-basic furnaces. The plant is running full time, and is pressed with orders. Inquiries are numerous, and are likely to result in heavy work for the beginning of next year. Basic boiler-plates are quoted £6 10s.; plates for general engineering work also £6 10s.; bars, up to 12in. flats and 5in. rounds and squares, £5 15s.; blooms and billets, £5. Competition in steel tin bars is much to the disadvantage of Staffordshire makers. Welsh steel tin bars are sent into this district at a figure below that asked for native made bars, the price being £5, a rise upon the last two or three weeks of 5s. per ton. Some Welsh makers—such as the Blaenavon Company—decline to quote this week for steel at all.

Messrs. Hatton, Sons, and Co., Bilston, report an improved demand for soft steel sheets and plates of first quality rolled from ingots made from their own converters.

It is understood here that the reason why some of the Welsh steelmasters are indisposed to accept any orders from local consumers is that they are behindhand with contracts for blooms for the American market and also with some of the new sleeper contracts for the Indian railways. Sleeper orders are reported to have recently reached some of these same firms from Australia in 2000 ton lots of 18in. wide section and of $\frac{3}{16}$in. thick plates. The sleepers for the Indian lines are largely of 14in. section.

The iron and steel exports for November are shown by the Board of Trade returns to have increased on the year 62,501 tons in quantity and £363,802, or 20·5 per cent, in value. The October returns of the exports of pig iron contrasted very unfavourably; but a much better trade was done in the month ended November 30th. The figures show an increase of nearly 20,000 tons in the quantity exported as contrasted with November, 1886, and an increase in value of 3·2 per cent. The countries with which this increased trade has been done are Germany, Belgium, Italy, and the United States.

In bar and angle iron likewise the steady progressive movement is kept up. The month's increase in the quantities exported is very nearly 3000 tons, and in value it is 15 per cent. The exports of railroad iron are again in the ascendant. The month's increase is 21,164 tons in quantity, and £101,296, or 32 per cent. in value. The increased trade has been done chiefly with Sweden and Norway, British North America, and the East Indies. There has been a very large decline in our exports of this description of iron to Australasia and Brazil. Cast and wrought iron shows the substantial increases of 3534 tons and £77,493 on the month. In hoops and sheets the month's increase is 3965 tons in quantity, and £24,019, or 8·5 per cent. in value. The past month's exports of old iron have risen in value by 103 per cent.

The following is a list of the principal classes of metallurgical exports:—

| Iron. | Month of November. 1886. | 1887. |
|---|---|---|
| Pig and puddled | £158,431 | £209,501 |
| Bar, angle, &c. | 119,849 | 137,660 |
| Railroad | 314,571 | 415,867 |
| Wire | 44 808 | 58,915 |
| Telegraphic ditto | 14,093 | 14,089 |
| Cast and wrought | 311,218 | 388,711 |
| Hoops, sheets, &c. | 281,409 | 305,428 |
| Old iron | 28,005 | 57,588 |
| Steel, unwrought | 155,811 | 143 818 |
| Tin-plate | 322.491 | 367,277 |
| Hardware and cutlery | 239,260 | 268,713 |
| Machinery | 656,364 | 809,103 |
| Steam engines | 287,286 | 240,969 |

A valuable discovery of coal has just been made at the collieries of the Pelsall Coal and Iron Company, near Walsall. The celebrated seam known as "the Staffordshire yard coal" has been struck at a depth of only twenty-one yards from the surface, and the company's engineers believe that it extends all over the estate of the company, an area of some 1100 acres. The difficulty which has hitherto surrounded the working of this seam in some localities has been the poorness of the roof, which has prevented its being got by gob roads. But the Pelsall Company believes that by driving straight into it they will be able to get it out at a profit, though at some points the seam may be found to be at a depth of eighty yards. The coal is very hard and bright, and experiments have proved it to be suitable for coking purposes, the analysis of the coke produced showing 1·49 per cent. of sulphur, and 10 per cent. of ash. Being a dense coke, it will bear a great weight in the blast furnace. The company have determined to erect Carr's disintegrating machines for pulverising the slack, which, after washing, will be put into coking ovens, which have yet to be built on land adjoining the blast furnaces. It seems likely that rectangular ovens, with a convex top, of 12ft. by 7ft. 6in. size, will be determined upon.

On Wednesday a boiler explosion occurred at No. 9 pit of the Pelsall Coal and Iron Company, by which three men were killed and several others were injured. The boiler was one of a set of three boilers, and was, it is stated, not usually worked at above 20 lb. pressure. The force of the explosion was very great and the plates of the boiler were opened out quite flat. No great damage was happily done to property, and the men in the pit were got out safely. After slight repairs the engine and winding appliances will again be in working order. The engineer and firemen are among the killed, and it is feared that some of the injured will also die. Fortunately No. 9 pit is not part of the main New Plant colliery of the company, or the results of the explosion might have been more serious.

A large machinery order has recently been placed by the Birmingham Small Arms Company with Messrs. Fielding and Platt, of Gloucester. The company has ordered several powerful hydraulic presses, with the necessary pumping engines, accumulator, and mains. The presses will be wholly of steel and gun-metal, and will be constructed to stand a working pressure of 3 tons per square inch. They will be provided with self-acting valve gear. The necessity for uninterrupted working which is involved in the execution of large machinery contracts has led to the provision in these presses of special appliances for preventing stoppage for the repair of valves. The hydraulic power will be supplied by means of a large pair of compound duplex pumping engines capable of indicating upwards of 150-horse power. These engines will form an interesting portion of the installation. They are of a new type lately invented and patented by Mr. John Fielding. They have several peculiarities, of which the most striking is the substitution of one valve to control the steam ports of both cylinders in the place of a slide-valve to each. I understand that the arrangement absolutely obviates the possibility of uneven wear, with its attendant leakage of steam and waste of power. These engines are adapted for all purposes for which pumps are employed. The valve-gear also is applicable to crank engines for impelling machinery of any kind.

Manufacturers of miscellaneous metal goods, in the production of which copper, brass, or tin are chief factors, are daily further advancing their prices in the Birmingham and Wolverhampton districts. Extensive orders are being received by these manufacturers alike from home consumers and foreign merchants who are operating in the interests of their export customers. The stock orders for next quarter's execution are heavy, and they are still arriving. Consumers are very anxious to cover their forward needs. Discount on cabinet brassfoundry is reduced 5 per cent. on the gross, while net goods are advanced 10 per cent. The brass lock furniture firms by alterations in discount have increased prices 15 per cent. Certain of the plumbers' brassfounders are preparing to advise new lists, which will show reductions in discounts equal to 5 to 7½ per cent. advance on the net on general goods, and 10 to 15 per cent. on heavy all-brass or all-copper goods. In general tinning an advance has occurred in the case of some firms of 2s. 4d. per cwt., while tinned nails, tacks, fancy staples, &c., have been advanced 10 per cent. on the net. Further advances are pending.

## NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

*Manchester.*—The market has necessarily been somewhat unsettled by the sudden drop which has taken place this week in Scotch and North of England warrants, but a strong tone is maintained so far as makers' iron is concerned, and since my last report was written there has been a considerable further upward movement in prices all round, with a very fair weight of business doing at advancing rates. As I have previously pointed out, the heavy weight of buying recently going on has to a large extent been speculative. There is no appreciably increased weight of iron going into actual consumption, and although there is an undoubted general activity in the steel trade, the iron using branches of industry are for the most part still only moderately employed. The belief is, however, generally prevalent that trade is really better, but as yet there is no sufficient improvement to establish prices on any materially higher basis. That prices have been excessively low—too low, in fact—is generally admitted, but buyers have been so long accustomed to these excessively low prices, that they have almost come to be regarded as the normal standard of values, and the somewhat rapid advance during the past fortnight, although it has only brought makers' quotations up to what is really only a legitimate and perfectly moderate basis, has been rather looked upon as an inflation of values which there was nothing in the condition of trade to warrant, and which could be only temporarily maintained. To some extent this opinion has apparently found a justification in the seeming collapse of warrant prices at Glasgow and Middlesbrough, and the underselling which has been going on amongst speculative holders, who have evidently considered it prudent to re-sell, even if they had to come below current prices, whilst they had the opportunity of realising a profit.

The Manchester iron market on Tuesday brought together a full attendance, but the reports from that day's Glasgow market, of a sudden drop of more than a shilling per ton in warrants, had the effect of unsettling business, and there was very little buying. Makers' quotations, however, were not appreciably affected; indeed, in most cases a further advance was being held to, and there was no anxiety to sell. So far as Lincolnshire and Derbyshire makers are concerned, they are already so largely sold over a considerable portion of next year that they are indifferent about booking further orders, and in some instances prices are quoted that are absolutely prohibitive. On the other hand, consumers and merchants are for the most part well covered for any prospective requirements over the first three and six months of the new year, and there are very few actually large buyers in the market. For Lancashire pig iron quotations have been stationary for months past at about 38s. 6d. to 39s. 6d., less 2½, for forge and foundry qualities, delivered equal to Manchester, and prices remain firm at these figures, with a moderate business doing. For Lincolnshire iron the average quotations are now about 37s. 6d. for forge and 38s. 6d. to 39s. for foundry, less 2½, delivered equal to Manchester, and in one instance 1s. 6d. to 2s. per ton above even these figures are the nominal quotations; but I do not hear of any business being done at the advanced prices; for Derbyshire foundry 42s., less 2½, delivered equal to Manchester, is now the minimum quotations, and in some instances makers have withdrawn quotations altogether. Good named brands of Middlesbrough are firm at 43s. to 43s. 6d., net cash, delivered equal to Manchester, and about these figures has been got; makers of Scotch iron were, notwithstanding the fall in warrants, also very firm, and holding, if anything, for rather higher prices.

In hematites the tendency of prices continues upwards, and 53s. 6d., less 2½, is now the minimum quotation for good No. 3 foundry qualities, delivered into the Manchester district, and at this figure sales have been made.

There is a continued strong upward movement in steel plates; during the week orders have been booked by local makers at £7 10s. for steel boiler plates delivered in the Manchester district; and on Tuesday, following the advance by the Scotch makers, their quotations were put up to £7 15s., representing an advance of fully 15s. to 20s. per ton during the past fortnight. For steel forgings rather better prices are also being got, but the actual advance in these is comparatively immaterial.

Manufactured iron makers, following the upward movement in pig iron, put up their prices about 2s. 6d. per ton upon recent minimum rates, and good qualities of bars were quoted at £5; hoops, £5 5s.; and local made sheets, £6 15s. per ton: with good Staffordshire qualities for galvanising purposes quoted at £7 to £7 5s. per ton delivered in the Manchester district. There is undoubtedly more business coming forward, but to a considerable extent this seems to be due to an anxiety on the part of consumers and dealers, in anticipation of an upward movement in prices, to buy for next year; and the maintenance of higher prices for finished iron will greatly depend upon the present advance in pig iron being held to. Manufacturers, however, are not at all anxious to sell even at the advance, and are very chary about committing themselves to anything like long forward delivery.

The condition of the iron foundry trades remains without any appreciable improvement, except that here and there in special classes of work there is some activity. Founders generally are only indifferently employed, and in the ordinary run of engineers' and builders' castings there is only a limited amount of work giving out, which is competed for at prices that are cut quite as low as ever. In builders' work especially prices are cut excessively low, and ordinary castings, such as columns and girders, are supplied and fixed at as low as £4 7s. 6d., and even in some instances at £4 5s. per ton, whilst ordinary pipe castings, although they are quoted at £4 15s., can be got readily at £4 10s. per ton delivered in the Manchester district. Notwithstanding the recent advance in Belgian rolled iron girders, these are still being delivered in this country in certain sections at under the price that English makers can take, but this competition is now being successfully met by the introduction of steel girders of English manufacture, which are not only very largely used in this country for constructive work, but are being shipped extensively to India and other parts. Steel girders, which range from £6 10s. to £9 per ton, according to section, are, of course, considerably higher in price than the Belgian rolled iron girders, but they have the great advantage of very much less weight in proportion to strength, which is a very important consideration when the question of long carriage is involved.

There seems to be rather more work stirring amongst engineers and machinists, but any actual improvement in trade generally is not yet very perceptible.

Messrs. Vaughan and Son, of West Gorton, have just completed for a firm at Havre a powerful overhead travelling crane, which has been constructed on improved designs recently introduced and patented by the above firm. This crane, which is constructed to lift upwards of forty tons, and has a span of 49ft., is rope-driven, and the shafts carrying groove pulleys transmit backward and forward motion to the various driving shafts by means of straight and cross belts, which obviate the objectionable shocks produced by the use of friction clutches, &c. There are two speeds both for the longitudinal and the cross traverse, and the main lifting barrel has also two speeds, whilst there is a smaller barrel at a quicker speed of hoisting for light loads. For the longitudinal traverse the speed can be varied from 50ft. to 100ft., and for the cross traverse from 35ft. to 50ft. per minute, and the lifting speeds range from 30ft. for three and a-half tons to 2ft. 6in. for forty tons, with a lowering speed about 60 per cent. faster than the hoisting speed. The large barrel has right and left-hand grooves, so that the chain suspending the weight is always kept in the same vertical position, and the middle part of the chain is carried by a cross-bar above, by which arrangement there are four chains in equal tension carrying the load. A simple but important improvement has also been introduced in the hook carrying the load, the head being arranged to rest on conical roller bearings, which enables the heaviest load to be swung round with perfect ease. The long cross shafts which give motion to the cross traverse and the hoisting gear are supported on ingeniously designed tumbler brackets—Vaughan and Foster's patent—which automatically drop down out of the way whenever the worm-box attached to the crab has to pass over them. The whole of the machinery is under the control of an attendant suspended in a cage underneath the crane, where he has an unobstructed view of the shop floor and the load which is being dealt with by the crane.

Messrs. Frank Pearn and Co. have secured the contract for the pumping plant of the Barton-on-Humber waterworks.

The annual meeting of the Manchester Association of Engineers was held on Saturday, and Mr. Samuel Dixon, of the firm of Kendal and Gent, Manchester, was unanimously elected president for the ensuing year. Mr. Alderman W. H. Bailey, the retiring president, who has filled the office for three years in succession, in responding to a vote of thanks, offered two or three pertinent remarks on questions of general interest. Alluding to technical education, he urged the importance of a careful selection of the men in whose hands it was placed; he considered that they ought not to permit a man, simply because he was a Greek scholar, to have control over the teaching of engineering in Lancashire. It seemed to him that if engineering was to be taught at all, it ought to be taught by a practical man, who had not only spent a portion of his time in the drawing-office, but who had also passed through the practical routine of the works. In such a case students would not be set to draw engineering details which had long been superseded, nor, on the other hand, would our class books be so far behind as was the case at present. Amongst several other important subjects which might very well claim the attention of the Association was the question of the copyright of drawings. It was scarcely necessary that he should tell them that the extent to which designs sent in reply to inquiries for quotations were copied and sent to rival houses for re-quotation was simply shameful, and demanded that some remedy should be found to protect th interests of engineers.

There is no material change to report in the condition of the coal trade; the demand all through continues very quiet, and collieries are barely kept going from hand to mouth on a restricted output at low rates. For shipment there has been a rather larger larger demand, but no really better prices have been obtainable.

*Barrow.*—There is a marked improvement in the iron trade this week, and prices have advanced fully 2s. 6d. per ton, mixed parcels of Bessemer being now quoted at 47s. 6d. per ton net, f.o.b.; No. 3 forge is quoted at 47s. per ton. The market at Glasgow on Wednesday showed a depreciation of 2s. per ton on hematites, but this was caused by speculation, and does not disturb the general firmness of the market. Makers are very well sold forward, and are declining forward deliveries except at a substantial advance in prices. Stocks remain very large, but they are firmly held. The general opinion is that the revival in the hematite pig iron trade is one of permanency, and that although a quieter tone may be expected during the approaching holiday season, the prospects of the new year are of a decidedly cheerful character. In the steel trade there is no change to note in the steady and brisk features which have characterised operations during the past few months. Light sections of rails are quoted up to £4 7s. 6d. per ton, and ordinary sections at £4 2s. 6d. net at makers' works, f.o.b. Billets and bars are in good demand, but slabs and blooms are neglected. A few orders are in the market for steel for shipbuilding purposes, and increased activity may be looked for, not only in this department, but in the shipbuilding trade generally. The business offering in shipbuilding is more active than of late, and several orders are expected to be placed with Barrow builders. The engineering trades are busier and a gradual return to activity is looked for in the early future. The engines which Messrs. Weston and Copeland are building for the Manx steamer King Orry are of the compound type, with 50in. high-pressure and 90in. low-pressure cylinders; the stroke will be 6ft. 6in. The boiler pressure will be 110 lb. to the square inch, and the engines are expected to develope forty-two revolutions per minute, from which a speed of eighteen knots is expected. There is every probability of a new line of steamers being established between New York and Barrow for the carriage of a cattle and general American produce trade. It is also contemplated to carry petroleum in bulk, for which purpose specially constructed sailing vessels will be built. Finished iron is a slow and moribund trade. Iron ore is strong in tone, and prices range from 9s. 6d. to 13s. per ton at mines according to quality. There is a busy trade in coal and coke at steady prices. Shipping is quiet, as is usual at this time of the year.

## THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE Sheffield Corporation, on the advice of their Parliamentary Committee, are to petition Parliament in favour of the Midland Company's proposal to take over the powers, rights, and privileges of the Dore and Chinley Railway Company, and to construct the line. It is expected that out of the Dore and Chinley line will spring another short railway, connecting it with the main route of the Midland at Bakewell. This could be easily effected by taking the metals down the Valley of the Derwent from Grindleford Bridge—near the Duke of Rutland's shooting-box—past Stoke Hall to Baslow—close to the Duke of Devonshire's "Palace of the Peak"—thence along the valley to Bakewell. There are no engineering difficulties, and it would form a pleasant alternative route to London, while opening up a most picturesque and fairly prosperous district. The entire length of the line would be only a few miles.

By the death of Mr. George Brown, of Rotherham, a prominent figure in the iron industry of South Yorkshire has been removed. Mr. Brown, who had reached his eighty-third year, had been connected with the iron trade all his life. With his brother, the late Mr. John Brown, he carried on the Rotherham Forge, of which he became the managing director on its being converted into a limited liability company in 1872. He was at one time a director of the British Wagon Company.

At the Yorkshire Iron and Steel Works, Penistone, the property of Messrs. Charles Cammell and Co., a serious explosion occurred on Monday morning. About 1000 men and boys are employed at the works, which are largely used for the manufacture of steel rails for inland delivery and export from Hull. The accident occurred in the Bessemer steel-making shop, and was caused by the plug at the base of a converter being forced out, thus enabling the molten metal to flow into the pit beneath, where, coming into contact with the moist earth, it exploded. The vessel was one of the largest in use by Messrs. Cammell and Co., but, as small heats were being blown, the charge was limited to nine tons of metal. Five blows had been already successfully carried out with the same converter, and there was therefore no reason to suspect any weakness in the vessel. The operation was going on in the customary style, when the plug suddenly gave way and the explosion occurred. About fifty men were near at hand at the time, and several of these had very narrow escapes. Nine men and one boy were injured, the latter somewhat seriously. The accident is believed to be due to the accumulation of gases evolved in the process, the action of which is not yet fully understood. The converter had only been in use eight or nine years, and was, therefore, comparatively young for a vessel of that kind.

South Yorkshire collieries continue to do a satisfactory trade with the principal port—Hull. Last month 152,544 tons were forwarded from Yorkshire collieries, being an increase on the month's tonnage of 21,600 tons. Of this, 105,576 tons were sent by rail. Since the opening of the Hull and Barnsley line the rates of carriage have been considerably reduced, causing the business to be greatly increased. Coalowners do not regard the present negotiations of the Hull and Barnsley Company with the Midland with unmixed feelings. The pits on the new route have been greatly benefitted by the more favourable tariff, and if the Midland were to work the line it is anticipated that the competitive advantages would be minimised.

Steel rails are the most fluctuating of all industries. During November the export trade reached a total value of £290,403 compared with £215,833 for November, 1886; for the eleven months, £3,022,956 against £2,249,304 for the corresponding period of 1886. The principal market was the United States, which took a value of £82,956; next came British East India, with £77,331; British North America, with £29,005; and the Argentine Republic, £28,536. These were all large increases on 1886. For the eleven months the United States showed an immense advance—£739,312 as compared with £220,095 for the corresponding period of 1886; British East Indies, £643,808, against £574,527; Australia, £341,878, against £400,929.

Professor Arnold Lupton, of Leeds, lectured here on the 3rd inst. on "Coal Dust a Cause of Explosions, and How to Lay It." It had been taken for granted in the past, he said, that fire-damp, or marsh gas, was the cause of explosions, and the eyes of engineers had been closed to every other cause. French mining engineers seemed to have been the first to suggest coal dust as a cause of explosions, though in 1876 Mr. Wm. Galloway, one of H.M. Inspectors of coal mines, sent a paper to the Royal Society in which he gave the evidence of experiments and investigations to prove that coal dust was the prime agent of destruction in colliery explosions, and this paper he followed up with others. Several mining engineers then took up the inquiry, and the Royal Accident Commission, Professor Abel, the Prussian Fire-damp Commission, and others made experiments. To Mr. Galloway, however, belonged the chief credit of the discovery that coal dust is the main agent in colliery explosions, and the knowledge he gave to them was of priceless value. It had been proved that very fine coal dust, when stirred up with air, was explosive, and also that coal dust not so fine was explosive in an atmosphere containing only 1 per cent. of gas—a percentage too small to be discovered by ordinary methods.

## THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Cleveland iron market has been during the past week in an excited condition. Prices have risen rapidly, and considerable quantities of iron have been sold, both by merchants and makers. There was a large attendance at the market held at Middlesbrough on Tuesday, but something like a reaction occurred on the receipt of a report from Glasgow that that market had become weak, owing to numerous realisations. Merchants' price for No. 3 G.M.B. became 33s. 9d. per ton, as compared with 32s. 3d. a week ago. Buyers are now again cautious, and do not offer more than 32s. 6d. Makers who were accepting the latter figure at the beginning of last week now quote half-a-crown more, and will not make any concession. Forge iron has advanced to about the same extent as No. 3, and the sales recently made have been at 32s. 6d. per ton.

Warrants have been fluctuating considerably, from 33s. per ton on the 6th inst. they advanced to 35s. on the 12th; but on Tuesday, the 13th, sellers were at 34s. 3d. and buyers at 6d. less.

The stock in Messrs. Connal and Co.'s Middlesbrough store increased 716 tons last week, the quantity held on Friday night being 327,999 tons.

The prospects of finished iron makers are brighter than they have been for a long time. Inquiries and orders are numerous, and considerably higher prices are being quoted. The following are the rates asked at Tuesday's market:—Ship plates, £4 15s. per ton; sheets, £5 17s. 6d.; common bars, £4 15s.; angles, £4 10s. All free on trucks at makers' works, less 2½ per cent. discount.

The demand for steel plates is greater than the supply, and prices have been raised about 15s. per ton. Steel rails have advanced 5s. and angles 7s. 6d. per ton. Some makers are refusing to quote at all.

The second meeting for this session of the Cleveland Institution of Engineers, was held at the rooms of the Institution, Newport-road, Middlesbrough, on the 12th inst., Mr. R. Howson, the president, occupying the chair. A paper was read by Mr. Jeremiah Head, on "The Biscayan Mineral Industry," or, in other words, the iron mines and blast furnaces in the neighbourhood of Bilbao. An interesting discussion took place afterwards, in which Mr. Richardson, Mr. Munroe, Mr. Wood, Mr. Cowper, and other gentlemen of Spanish experience took part. The general conclusion which seemed to be arrived at was, that the Bilbao iron ores excel all others in the market for easy reduction into good hematite pig iron; and that owing to their nearness to a good navigable river, and their situation only three or four days' voyage from English ports, they are not likely to be readily superseded by any others. But should their market value rise considerably, it will lead to the development of the mineral districts in other parts of Spain, of which there are several, as well as of those in Portugal and various other countries. All that is really required for this purpose is British capital and energy. The new iron mines and mineral railway in the North of Sweden were alluded to. It was stated that whilst these ores are exceedingly rich and pure, they are at the same time most refractory and difficult to reduce. Several consignments have been in past times imported into Middlesbrough and tried in the blast furnaces there. But the above difficulty, which has not yet been surmounted, has prevented the permanent establishment of a trade in them. A vote of thanks to Mr. Head terminated the proceedings.

One of the greatest difficulties which invariably follow in the wake of improved trade is the unsettlement of the minds of industrial operatives. It is but fair and right that they should be kept informed of the real condition of their interests whether favourable or unfavourable, and that they should have their full share of prosperity, as they always must have of adversity. But, unfortunately, many of the papers, from which almost exclusively they get their information, do not give it to them in the form of "the truth, the whole truth, and nothing but the truth." When we consider the narrow sphere of observation of the average British workman, the want of opportunity to mix with any but those of his own grade, the scantiness of his education, the untrained nature of his judgment on general subjects, his frequent lack of moral courage, and his numerous class prejudices, we cannot be surprised if his beliefs are mainly regulated by his wishes. At the present time the cheap journals alluded to are busily occupied in "writing up" the improvement in trade. Day by day advanced prices are recorded and dwelt upon. Nothing is said about those which have remained stationary or fallen. It is what Glasgow merchants call "bulling" all round. "Bearing" is out of fashion. Now what these advances practically mean, where they take place and are maintained, is that producers are fully occupied for the present, and will get higher prices, in—say six months' time—for the work to follow existing contracts. But the idea which the newspaper-instructed workman is day by day absorbing is that his employer is getting the advance now, and is withholding from him the share thereof. Consequently, we may soon expect a crop of labour difficulties. These, when they come, will most probably have a seriously-retarding effect on the advance towards more prosperous times.

The slowness with which the benefit of improving trade is realised by producers is well seen by an examination of Mr. Waterhouse's recent report on the bi-monthly returns of the North of England Board of Conciliation. The net average selling price of finished iron of all kinds during the two months ending October 31st was £4 12s. 6d. per ton, as against almost identically the same figure for the previous two months. This proves conclusively that up to October 31st no benefit had accrued to this class of producers from the supposed improvement in trade.

## NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron warrant market has been excited this week, in consequence of violent fluctuations in prices. On Monday the quotations advanced to close upon 43s., and on the following day, both at the forenoon and afternoon market, the price dropped to a much greater extent than usual. These rapid changes in price were to be expected, as those who have been holding pigs during a long period of depression have been tempted to realise.

Still there are features in connection with the trade which seem to indicate that a solid improvement may be experienced. One of these is the fact that the ironmasters are adding to the number of furnaces in blast, which they presumably would not do if they had no good prospect of a sale for their iron. The shipments of the past week amounted to 12,557 tons, as compared with 7260 in the corresponding week of 1886. Of the total amount fully 5000 tons went to Italy, and 1400 to the United States, while there is a gratifying improvement in the coastwise shipments, which for a long time have been comparatively poor. There is still a considerable weekly addition being made to stocks in Glasgow warrant stores.

Another advance of a substantial character has been made this week to makers' prices. Free on board at Glasgow, Gartsherrie, f.o.b., No. 1, is quoted at 48s. 6d.; No. 3, 45s. 6d.; Coltness, 54s. and 45s. 6d.; Langloan, 52s. 6d. and 46s.; Summerlee, 52s. 6d. and 45s.; Calder, 48s. 6d. and 44s.; Carnbroe, 47s. and 43s.; Clyde, 45s. 6d. and 40s. 6d.; Monkland, 44s. 6d. and 42s.; Govan, at Broomielaw, 44s. and 42s.; Shotts, at Leith, 49s. and 46s.; Carron, at Grangemouth, 52s. 6d. and 42s. 6d.; Glengarnock, at Ardrossan, 49s. and 43s. 6d.; Eglinton, 45s. and 42s. 6d.; Dalmellington, 46s. and 43s.

On the Glasgow Exchange there has been an upward movement in the prices of Cleveland iron corresponding to that in Scotch; but the amount of actual business doing in these warrants does not appear to be very large. The imports of Cleveland iron into Scotland in the past week were 8703 tons, and the total arrivals for the year to date show an increase of 21,029 tons.

The prices of Scotch hematite pig iron have been materially advanced. This was rendered necessary by the increased cost of Spanish ore to the ironmasters, which is about 3s. a ton more than it was a year ago. Hematite is quoted at 50s. to 52s., which represents a rise from the lowest point of about 6s. a ton.

In consequence of the advance in the price of hematite, the makers of Siemens steel have been obliged to revise their prices. As yet they are reluctant to quote specific rates; but the new contracts for vessels are understood to be taken at advanced prices.

Makers of malleable iron are all reported to be very busy and well booked up for some time. There is a further increase in prices for fresh work. Merchants quote best bars £5 5s.; common bars, £5; rivet iron, £5; nut iron, £4 15s.; angles, £5; and plates, £5 12s. 6d., all less 5 per cent. discount.

The past week's shipments of iron and steel goods from the Clyde embraced locomotive engines to the value of £6600 for Rangoon; machinery, £9500; sewing machines, £1668; steel goods, £6500; and general iron manufactures, £36,600.

The coal trade is fairly active for the season, although as yet it has not received much impetus from the animation that prevails in other branches of the trade. Some kinds of coal are hardening a little in price, but as yet there is no general advance. The past week's shipments were good, embracing from Glasgow, 24,103 tons; Greenock, 87; Ayr, 8498; Irvine, 1803; Troon, 5150; Ardrossan, 2883; Burntisland, 12,955; Leith, 1525; Grangemouth, 12,071; Bo'ness, 5314; Granton, 2128; Methil, 4624; and Port Glasgow, 180; total 81,321, against 69,035 in the same week of 1886.

## WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

A CURIOUS accident has happened to the Evance Coppee coke oven at Cyfarthfa Works. The intense heat pulverised the brickwork, and fused the cast iron uprights, bringing down a portion. Repairs are now going on, and the mischief will soon be remedied. Fortunately it has not interfered much with the supply of coke to the steel works.

I have notified on several occasions of late a sign or two of brightening prospects in the steel works. The re-starting at one point, purchase by a Sheffield firm of a Welsh works at another, even the transfer of Dowlais Steel Works to the seaboard, all showed a more hopeful character, and now this week prices are hardening all round. Pig iron is advancing, so also angles and bars. Even so for steel rails, though some can still be had, heavy section, for £4. Yet £4 5s. is again quoted, and light rails are up to £5 12s. 6d. By the end of the week I shall fully expect 5s. advance per ton all round.

The quotations at the Exchange, Swansea, on Tuesday, may be taken as fairly representative of the current ones of the whole district. Pig iron, Glasgow, 44s. 3d. cash; Swansea pig, 48s. at furnaces; cheapest offered Middlesbrough, 34s. 6d. for No. 3; merchant bars, £4 10s. to £4 12s. 6d., showing an advance of 2s. 6d.; steel rails, £4 to £4 5s.; light, £5 5s. to £5 12s. 6d., some kinds offering as low as £4 17s. 6d.; Bessemer blooms, £4 5s.; bars, £4 15s.; Siemens bars, £5 2s. 6d.

Ironmasters are in a state which may be described as expectant, and any day are hopeful of a "boom" or something approaching to it. There seems to be an impression that the "cornering" which tin has met with is to be applied to pig iron, and all iron and steel manufacture would follow, just as tin plate has followed the advance in tin. This is now quoted at £166. The latest prices for tin plates are:—Iron coke tin, 15s. 3d. to 16s.; Bessemer steel cokes, 15s. 9d. to 16s. Exports last week were very satisfactory, 95,597 boxes having been despatched from Swansea alone. In the face of an advancing tin market, and the rumours of a stoppage, the market closed firm.

While on the subject of metals, I must note the gold discoveries in North Wales, which are arousing the keenest attention. Into that most secluded of districts, which is only frequented by the shepherd and, for the few summer months of the year, by the most adventurous of tourists, you may now see any day skilled assayists, Australian miners, members of the London press, energetic mining engineers, and keen speculators. I know the district well, having traversed it, and have been by many of the abandoned workings. The discovery is not a new one, and a good deal of money has been sunk there on the artesian well system of getting more up. The last great venture, about twenty years ago, was by a gentleman who had had considerable experience in gold mining in South America. He stated then that there was plenty of gold there.

It is announced that in the course of the month passenger traffic will begin on the Treforest, Caerphilly, and Newport Railway. Some little excitement has been caused amongst the holders of Barry Railway and Dock scrip by the statement that it has been omitted to apply for Government sanction to a connection between the Barry and Taff at Hafod, and that a delay of two years must result. I do not think there is much cause for alarm, as an arrangement is likely to be brought about between the two railways. I note that stock is firm at 10¼. Still, if the statement be correct in all details, it gives the Taff Vale the key of the situation.

Rumours have again been floating about the district that the sliding scale of the Miners' Association is in jeopardy. This is because the colliers of the district have voted against it by a small majority. The real case seems to be that the colliers in question in this way express their approval of Mr. D. Morgan being their representative for the Cheshire and Merthyr district. As for the scale, I am assured that they will not on any account consent to forego its advantages. This is a timely conclusion, as indications point to an advance.

The tone of trade is firm, and prices are improving, though slowly. Latest quotations are:—Steam, 9s. to 9s. 6d.; seconds, 8s. to 8s. 6d.; inferior coals, 7s. 9d. to 8s.; small steam 3s. 3d. to 3s. 6d.; house coal, 8s. 3d. to 8s. 6d.; small, firm at last quotation; pitwood, 15s. 6d. to 15s. 9d. Judging from the contracts being placed, prospects are getting hopeful for a steady trade during the winter months, and this without any adventitious aid. Should the iron and steel boom come, or any difficulty arise between either of the great Powers, those who have placed contracts will deserve to be congratulated. Present signs are more significant of a rising than of a falling market.

## NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE so far favourable results of the trade conventions at present operating have given a stimulus to the formation of more, so that the air is full of projects for establishing them all over the country, the latest phase of fashion having been to form a convention of iron merchants for North Germany to work hand in hand with the grand wrought iron one, and to this end a meeting has been held in Berlin, instigated by the large and eminent firm of iron merchants, James Ravené and Son. The wire rod convention has also at last been definitely constituted, and the wire nail one is shortly to follow. All this has given great strength to the iron markets; prices are firm, and a steady development of the trade is looked forward to for a long while to come, and no fear of prices receding is anticipated in face of the good demand and the present more favourable indications on all the foreign markets. The Silesian works, in spite of Russia being closed against them, are well situated just now as regards sales of manufactured iron, and crude keeps up its price well, as, with the exception of 40,000 t. in dealers, there is none disposable, all being in makers or manufacturers' hands. The price of forge is M. 54; foundry pigs, 55 and upwards; bar iron, 135 to 140; girders, 150 to 155; and common plates, 160 to 165 p.t. Also both from Belgium and France only favourable reports are received, and in the latter country now the three groups of works are satisfied with their position, only at Paris the trade is again unsettled, and a "bear" movement at work.

As was anticipated, the ore markets of this country are reviving a little; as Spanish ore is rather difficult to get, demand is increasing and prices are rising, raw steelstone being now M. 9 and roasted 12 to 12·10, whilst Luxemburg sorts range from 2·20 to 3·20 p.t., all at mines. The demand for pig iron has continued very brisk. Spiegel has not changed much, but M. 52 have been paid for the lower grades. The prices are firm, and the more favourable accounts of the American market are likely to keep them so. Forge pig is in very full demand at the stipulated convention figure of M. 46½ to 48 p.t., which is cheerfully paid. Many contracts are already closed till April, and some even to June, next year. Foundry pig has been in better request lately, and convention price the rule. Basic is in moderate demand at M. 44; Bessemer, 49 to 51; Luxemburg, which has risen again, 34 to 36 p.t. The position of the manufactured iron trade is a firm one, demand is satisfactory, and present prices are remunerative and firm at the minimum of M. 122·50 p.t., which is not likely to be raised for some time, unless raw iron is unnecessarily advanced. Export is dull, but the works have orders enough on hand for the coming quarter, so are not yet in a strait, but the inland demand cannot hold on, as at present, for ever, and what then if export should fail? The convention is doing well just now certainly, for at a State tendering in Berlin the Silesian offers were M. 140 and 145 for bars, which is M. 30 above similar offers last year. Again, it is regarded as a very encouraging result that 9000 t. monthly have been contracted for by the wrought iron sales bureau, considering that contracts were still running when it first came into operation. Hoop iron is still in very brisk demand, and prices range up to M. 130 p.t. Plates continue in the same stagnant condition as for a long time noted. Sheets, on the other hand, remain firm at M. 142 p.t., with orders enough at this price for the full capacity of all the works for weeks to come. At the same time that the sales syndicate for wire rods was announced, the prices were fixed for inland sales at, for iron, M. 116, and for steel 115 p.t., as noted hurriedly last week; but of course for export these prices are not normal, and must be regulated according to English and Belgian competition and American demand. Girders are noted M. 115 in the West; angles, 132; and charcoal plates, 210 to 240 p.t. The steel works are pretty well engaged, mostly on domestic railway material. The last tendering at Frankfurt for rails showed M. 121 to be the lowest offer, and 123 the highest, and for sleepers 115, which, however, is a great improvement on former prices; fish-plates were 98 p.t., all at works in Westphalia. At Elberfeld, where 9000 t. of rails and 11,000 t. of sleepers were tendered for on the 6th inst., Krupp was the lowest for rails at M. 118, the Aachener Huttenverein being the lowest for sleepers at M. 114½ p.t. No foreign offers were made in either case. Light rails are noted M. 100 to 110 p.t. On the 22nd inst. 130,000 t. of steel rails and 149,000 t. of steel sleepers, besides 30 t. of crucible steel points and a great deal of small ironwork, are to be tendered for by the State Railway Department at Frankfurt. The wagon works are gradually emerging from their long torpor. This week again 125 coaches and baggage, and 525 goods wagons have come to the shops; this, with those of last week, and other lots in expectation will keep them from desponding altogether. The machine works keep receiving fresh orders, and are mostly satisfactorily busy; but prices, though a trifle better, are still, through keen competition, down at starvation level. The boiler and constructive ironworks are rather better off in the latter respect. The brass foundry trade is rather demoralised, for buyers refuse to pay the higher prices for the finished goods necessitated by the rise in the raw metals required, and although iron has gone up so much of late. The market prices quoted are, for bronze, M. 1·90, phosphor bronze, 2·00; and red copper castings, 1·80 p. ko.

It has now been decided to abandon the present mode of heating the State railway carriages by means of pressed turf charcoal and saltpetre, and to use steam for the purpose. When will these chopping and changings cease! Why not let well alone? Nobody complained, but where such superfluity of officials in every State Department exists, there are sure to be enterprising busybodies always proposing some change or other, the result being that some alterations of arrangement in some department or other, some petty in the extreme, are constantly being published in the official *Gazette*.

In the end Krupp has felt himself constrained to publish a letter in the *Moniteur des Interêts Matériels*, defending himself against the attacks of the Belgian press agitation with regard to his deliveries of cannon to that country. The only points of interest to those outside the controversy, and not materially affected, are that Krupp denies that within the last seventeen years even one of his cannon has burst; that ever from the beginning of his manufacture has he used any but crucible steel for them melted out of puddle steel mixed with best wrought iron, as the only really trustworthy material, though it is so much more costly, and that he never used Siemens-Martin or Bessemer metal instead, which are not trustworthy for cannon, and were both invented long after he had discovered the proper mixture for toughness, durability, an purity. He repudiates altogether the insinuation that he ever substituted Bessemer for crucible steel in an order for rails; and lastly, he says that the slight indentation of 1 mm. deep, 2 mm. broad, and 163 mm. long in his 24 cm. gun delivered to Belgium in 1863, and after 151 rounds had been fired, was erosion, whilst the scoring in the opposing cannon, made by the Cockerill Company, which was only 9 cm. bore, was caused because the steel from which it was made contained blow-holes. However, the agitation in Belgium has borne some fruit, and the old arsenal at Liége is now executing some of the guns for the new fortifications.

A Turkish journal reports that a foreign syndicate is in treaty with the Porte for the exploitation of the country's coal mines, a considerable money advance being a first condition, but which is not yet settled, whilst an English syndicate is treating for the metal mines, £T.150,000 having been promised as a *douceur* on completion of the contract.

PRESENTATION TO MR. C. E. STRETTON.—At a meeting held on Wednesday, the 7th inst., in the Crown Court, Town Hall, a presentation was made to Mr. C. E. Stretton, in recognition of his services to railway servants. The presentation, subscribed for by about 4000 railway servants in the United Kingdom, took the form of a handsome timepiece and aneroid. The timepiece is a model in miniature of the Nasmyth steam hammer with boiler attachment, the hammer, by means of an ingenious mechanical contrivance, doing duty as the pendulum, while the dial and remainder of the clockwork are placed in the boiler. The timepiece is of Parisian manufacture, and is most cleverly constructed. It is proposed to place on a silver plate the following inscription:—"Presented to Clement E. Stretton, Esq., by the Mayor of Leicester, on behalf of the railway servants of the United Kingdom, in recognition of distinguished services, especially in connection with the Hexthorpe disaster, also for the promotion of safety in railway travelling.—Leicester, December, 1887." Mr. C. E. Stretton thanked the Mayor for his kindness in making the presentation, and the 4000 subscribers for their handsome testimonial. As the Mayor had said, it was the custom some ten or fifteen years ago, when a railway accident took place, to suppose that the servants in charge of the train or signalbox must be the guilty parties, but time had since shown that this was not of necessity the case. It had now been proved that a railway servant could not be held criminally responsible if the appliances with which he worked were inefficient. The Hexthorpe accident, one of the most disastrous that had happened in this country for a long time, was proved to have been solely attributable, not to the negligence of the driver and fireman, who were arraigned for manslaughter, but to the suspension of the "block" system and the failure of an inefficient brake.

## NEW COMPANIES.

The following companies have just been registered:—

*Pier Company of Nice, Limited.*

This company purposes to acquire the promenade pier at Nice, and the concession which has been granted in relation thereto, and to renovate and complete such pier, and all requisite conveniences. It was registered on the 3rd inst., with a capital of £60,000, in £5 shares. The subscribers are:—

| | Shares. |
|---|---|
| Emmanuel Weigner, 10, Southampton-street, Holborn | 1 |
| John Coe, 5, Victoria-street, Westminster, accountant | 1 |
| F. C. Furness, 5, Victoria street, Westminster, engineer's assistant | 1 |
| J. M. Solomon, C.E., 7, Lowhill-road, W. | 1 |
| W. C Sturt, 4 Westminster-chambers, architect | 1 |
| W. M. Tew, 9, Victoria-chambers, accountant | 1 |
| C. H. Driver, 5, Victoria-street, architect | 1 |

The number of directors—exclusive of debenture directors—is not to be more than five; the subscribers are to appoint the first. The company in general meeting will appoint remuneration. Qualification of future directors, £100 in the capital of the company or in debentures. The first issue of debentures will be limited to £60,000.

*Ruabon Brick and Terra-cotta Company, Limited.*

This company proposes to acquire property at Ruabon, Denbigh, and to carry on business as brick, tile, and terra-cotta manufacturers, colliery and quarry proprietors. It was registered on the 5th inst., with a capital of £35,000, in £5 shares, with the following as first subscribers:—

| | Shares. |
|---|---|
| Thos. North, 14, Frederick-crescent, North Brixton | 1 |
| J. Mulcahy, 3, Belfour-street, South Lambeth, clerk | 1 |
| J. P. Russell, 66, Durham-road, Manor Park, Essex | 1 |
| H. Simmons, 4, Budhurst-road, East Hill, Wandsworth | 1 |
| W. Wallis, Pattenden-road, Catford | 1 |
| G S. Howatson, 7, Princes-square, W., engineer | 1 |
| W. H. Russell, 66, Durham-road, Manor Park, Essex | 1 |

The number of directors is not to be less than two, nor more than five; qualification, 100 shares each; the subscribers are to appoint the first.

*Wilhelmina and New Phœnix Tin Mining Company, Limited.*

Upon terms of an agreement of the 1st inst. this company proposes to acquire and work the New Phœnix Mine and the Wilhelmina Mine, situate in the parish of Altarnun, Cornwall. It was registered on the 3rd inst., with a capital of £100,000, in £1 shares, whereof 30,000 are 10 per cent. preference shares. The vendors are Mr. and Mrs. Joseph Bailey, of Lamerton, near Tavistock, and the following provision is made in the agreement, viz.: That the company shall not investigate or require the production of the title of the said parties to grant such leases, or to make any requisition in respect thereof. The purchase consideration is as follows:—To Mr. Joseph Bailey, £6000 cash and 16,500 fully-paid ordinary shares; to Mrs. Bailey, £6000 cash and 16,500 fully-paid ordinary shares; and to Mr. George Shenton, of 35, Craven-street—in consideration of certain agreements on his part, and of labour, risk, and expenses incurred in the formation of the company—£8000 cash and 17,000 fully-paid ordinary shares. A further sum of £7500 is payable in cash or preference shares in the event of the company issuing more than 80,000 shares. The subscribers are:—

| | Shares. |
|---|---|
| *The Hon. Frederick Charles Howard, 34, Fopstone-road, South Kensington | 1 |
| *G. W. Page Moor, 9, Carlisle Mansions, S.W. | 1 |
| *W. Forster Shaw, 123 and 124, Palmerston-buildings, merchant | 1 |
| *W. H. Crane, 11, New-square, Lincoln's-inn, barrister | 1 |
| F. Peachey, jun., Tremont, Anerley Park | 1 |
| A. Baldwin, Scarbro'-road, Finsbury Park | 1 |
| E. Scott, Elms-road, Clapham | 1 |

The number of directors is not to be less than three, nor more than seven; the first are the subscribers denoted by an asterisk, and Mr. J. Fletcher Pagent, F.G.S., of Plymouth. The remuneration of the board will be at the rate of £100 per annum for the chairman, and £75 for each director, to be doubled in any year in which 20 per cent. dividend is paid on both classes of shares.

RAILWAY MATERIALS FOR ITALY.—The Secretary of State for Foreign Affairs has received information that the Italian Ministry of Public Works will invite tenders in the month of January next for the construction, by private firms, of the railway lines from Messina to Cerda and from Eboli to Reggio, the latter including various branch lines. Tenders can only be submitted by such firms or parties as are known to and invited by the Government authorities.

A LARGE SHELL FOR THE DYNAMITE GUN.—Messrs. Brown and Brothers, of Waterbury, have completed the shell for a projectile of enormous size, for the dynamite gun to be used on the new cruiser now being built for the Government. It is a seamless drawn brass shell, 6ft. 8in. long, 14in. inside diameter, $\frac{3}{16}$in. thick, and weighs 200 lb. The shell, with its conical head, is all in one piece, being forced into shape by a heavy hydraulic ram. The drawing of the shell was witnessed by Lieutenant Zalinski and G. H. Reynolds, consulting engineer of the Pneumatic Dynamite Gun Company. The shell is intended to carry 600 lb. of explosive gelatine, shells carrying 55 lb. only having been used in the recent experimental trial in New York Harbour, when a small vessel was demolished at a distance of a little over a mile. The new 150-ton Krupp gun now being built will carry a shell 15¾in. diameter and 5½ft. long. This shell will weigh 2310 lb., and require 1067 lb. of powder to fire it. The difference in the cost of making and employing these two varieties of guns, carrying shells of about the same size, is something enormous.—*Scientific American.*

## THE PATENT JOURNAL.

*Condensed from the Journal of the Commissioners of Patents.*

### Application for Letters Patent.

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

*6th December*, 1887.

16,738. HORSE-SHOE NAILS, C. Gibbs and J. Olson, London.
16,739. BOTTLES, R. Howell, London.
16,740. BICYCLE LAMPS, T. Greatrex, J. Record, and J. Whitehead, Birmingham.
16,741. GRAIN BINDERS, H. J. Allison.—(*The Milwaukee Harvester Company, United States.*)
16,742. SIGNALS for ENGINES, &c., J. C. Ricketson, London.
16,743. DOUBLE-TREES, J. R. Freeland and E. C. Bradley, London.
16,744. SEATS for FACILITATING VENTILATION, W. Y. Ober, London.
16,745. CRUCIBLE HEATING ARRANGEMENT, J. Noble and B. H. Thwaite, Liverpool.
16,746. DRESSING BRICKS, W. G. Watson, Newcastle-upon-Tyne, and J. Judge, Wallsend.
16,747. SAFETY TARGET, &c., F. L. Stephenson, London.
16,748. MECHANICAL MUSICAL INSTRUMENTS, A. Maxfield, London.
16,749. MUSTARD HOLDER, H. G. Boston, York.
16,750. PRINTING MACHINES, &c., J. Thomlinson, Glasgow.
16,751. MECHANICAL TOY MILK CART, G. F. Lutticke, London.
16,752. TRAP TWISTING FRAMES for DOUBLING YARNS, J. Farrar, Halifax.
16,753. MINERS' PICK and HATCHET, H. Walker, South Normanton.
16,754. LIFE-BUOYS, J. D. Allen, Bath.
16,755. PREVENTING HEATING of GUNS, A. Sparrow.—(*S. Baldwin, New South Wales.*)
16,756. DRIVING BELTS, H J. Fenner, London.
16,757. WINDOW CLEANING, W. Hutchinson, Newcastle-upon-Tyne.
16,758. FIXING WINDOW CURTAINS, E. W. Hughes, Bath.
16,759. TOBACCO, A. T. Lendrum, Cork.
16,760. NUT LOCKS, J. W. Parks and P. G. Roquemore, London.
16,761. MEASURING TAP, W. Lister and F. C. Suggate, Crewe.
16,762. LOAM SAND CORES, &c., W. B. Fenton, West Bromwich.
16,763. MINING SLIDE, G. Burnside, North Newherrington.
16 764. DISINFECTING BOOKS, J. T. Dobb, Sheffield.
16,765. GRINDING, J. McGregor, Sheffield.
16,766. ATTACHING CALKS, A. L. Lade and W. Seedhouse, Sheffield.
16,767. GRINDING the SWAGED EDGES of CUTTERS, J. McGregor, Sheffield.
16,768. LOCK NUTS, J. Wragg and W. Smith, Sheffield.
16,769. JOINERS' PARALLEL VICE, &c., R. Melhuish, London
16,770. MINERS' SAFETY LAMPS, W. Wood, London.
16,771. CRUCIBLE STEEL, A. Fieldsend and J. E. Bott, Manchester.
16,772. ELECTRIC BELLS, &c., J. A. Macdonald, Birkenhead.
16,773. STEAM ENGINES, J. and R. Mills, Glasgow.
16,774. CAPS for INKSTANDS, B. C. Levey, London.
16,775. BOXES with ENAMELLED PLATES, F. Edmonds, London.
16,776. VEHICLE WINDOWS, S. S. Bromhead.—(*F. H. Jury, United States.*)
16,777. SAFETY STIRRUP, T. Gloster and T. Ross, London.
16,778. INDICATING DISTANCE RUN by CYCLES, R. M. Lowne, London.
16,779. SAFE-LOCKS, H. Stanynought, London.
16,780. SUPPORTING ROOFS of MINES, &c., G. Meyer, London.
16,781. BAGGING CHAFF, G. E. Vaughan.—(*W. Andrews and A. W. Beaven, New Zealand.*)
16,782. FURNACES, W. R. Lake.—(*W. W. Dashiell, United States.*)
16,783. SMOKELESS, &c., GUNPOWDER, C. F. Hengst, London.
16 784. IRON SHELLS for MACHINE GUNS, W. Pilkington, London.
16,785. PIPES of PNEUMATIC BRAKES, B. Heimsolth, London.
16,786. MUSIC CABINETS, F. Duffing, London.
16,787. COOLING APPARATUS, H. E. Newton.—(*E. Theisen, Germany.*)
16,788 RAILS for TRAMWAYS, G. Smith and F. Nockold, London.
16,789. PREPARING GRAPE JAM and JELLY, W. Wild, London.
16,790. DYNAMO-ELECTRIC MACHINES, S. C. Hamberg, London.
16,791. AERATED DRINKS, L. G. and S. M. Chinnery, London.
16,792. KEYBOARD for PIANOFORTES, J. J. Bender, London.
16,793. APPARATUS for RECEPTION of COIN and the AUTOMATIC DELIVERY of GOODS, C. H. Russell, London.
16,794. STEPS for VELOCIPEDES, H. H. Lake.—(*T. Benfield, United States.*)
16,795. HYGIENIC BANDAGE for WOMEN, J. Grossman, London.
16 796. PREVENTING SLAMMING of DOORS, H. H. Lake. (*J. G. and W. L. Witte, United States.*)
16,797. ROPE GRIPS or SELVEDGE STROPS, A. J. Boult.—(*A. K. Evans, Canada.*)
16,798. MINCING MEAT, W. P. Thompson.—(*O. D. Woodruff, United States.*)
16,799. STOPPERS for BOTTLES, T. Etty, Liverpool.
16,800. OMNIBUSES, S. and F. E. Andrews, Liverpool.
16,801. MOWING MACHINES, A. J. Boult.—(*A. Mowat, Canada.*)
16,802. TOOTHED WHEELS, W. P. Thompson.—(*P. de Monicourt*, ———.)
16,803. ROLLER BEARINGS for SNATCH BLOCKS, H. A. Rooke, Liverpool.
16 804. FLUSHING CISTERNS, A. J. Boult.—(*M. C. Booth and J. O. Parker, Canada.*)
16,805. DISTILLATORY APPARATUS for CHEMICAL OPERATIONS, W. T. Walker, London.
16,806. APPARATUS for use in CHEMICAL OPERATIONS, W. T. Walker, London.
16,807. INCANDESCENT ELECTRIC LAMPS, D. Urquhart, London.
16,808. CHILD'S TOY GUN, D. B. W. Sladen, London.
16,809. FIRE-LIGHTER, A. Sellar, London.
16,810. COLOURING MATTER for DYEING, &c., R. and J. W. C. Chadwick, London.
16,811. SERVING ROPES with SPUN YARN, H. R. A. Mallock and A. Froude, London.
16,812. MAGAZINE FIRE-ARMS, G. Shepheard and H. F. Holman, London.
16,813. MECHANISM for TRANSMITTING MOTION, G. F. Evans, London.

*7th December*, 1887.

16,814. SYPHON FLUSHING TANKS, G. F. Parkinson, London.
16,815. PORTABLE HEARTHS, W. Logan, Monkwearmouth.
16,816. AUTOMATICALLY SUPPLYING WATER to, CUTTING WATER off from, and FLUSHING WATER TROUGHS, W. M. Muirhead, Glasgow.
16,817. GAS GOVERNORS, H. W. and A. F. Cole, Stourport.
16,818. OPENING, &c., WOOL, J. W. Thornton, Halifax.
16,819. CURVILINEAR DOOR or GATE HINGE, T. Pease, Birkenhead.
16,820. VELOCIPEDES, H. J. Lawson and W. Phillips, Coventry.
16,821. SPINDLES for SLUBBING FRAMES, W. Shore, London.
16,822. CHIMNEY COWLS, J. Smith and H. Glaves, Birmingham.
16,823. APPARATUS for SKETCHING, G. L. Garner, London.
16,824. ELECTRIC ILLUMINATION of THEATRES by FIRE-PROOF MEANS, S. Sudworth and E. L. Berry, London.
16,825. FOUNTAIN PENS, J. Barker and H. J. Rogers, Lavington.
16,826. ULCER CURE, A. H. Brazier, London.
16 827. ARCHITECTURAL and ENGINEERING TOOL, J. Short, Glasgow.
16,828. COATING METALS with ZINC, &c., A. J. Ash, Birmingham.
16,829. ENGINES, W. H. Richardson and W. Greaves, Manchester.
16,830. TROUSERS' STRETCHER, Farnell and Sons, Leeds.
16 831. STEAM BOILERS, R. Scott, Newcastle-on-Tyne.
16,832. HYDRAULIC LIFTS, B. Turner, London.
16,833. LINE THROWING with a GUN, B. W. Stevens, Birmingham.
16,834. PEEP SHOWS, H. Knight, Ryde.
16,835. SHADES for CANDLES and LAMPS, M. Grimston, Birmingham.
16,836. CALENDER or SMOOTHING MACHINE, R. Crawford, Belfast.
16,837. BAGGING CHAFF, G. E. Vaughan.—(*W. Andrews and A. W. Beaven, New Zealand.*)
16,838. WATCH-KEYS, J. Kendal, London.
16,839. WINDOW, DOOR, and similar ARCHES, C. Dungate, London.
16,840. COMBINED HEATING STOVE and BOILER, W. H. Butlin, Stonehouse
16,841. CARTRIDGE, H. P. Hurst, London.
16,842. GENERAL STRUCTURE of PIANOFORTES, A. Craig, Belfast.
16,843. COSMOPOLITAN MONEY CHECK, G. J. Courcelle, R. and J. Porter, and J. Barriff, London
16,844. BICYCLE and TRICYCLE WHEELS, D. R. Ashton, London.
16,845. FIXING TUBULAR SHEET METAL HANDLES to SAUCEPANS, &c., B. Burford Lee and O. Banks, London.
16,846. BLOWING MEAT with FAT, A. J. and F. W. Trueman, London.
16,847. LINEN DAMASKS, A. M. Hart, London.
16,848. VENTILATOR and SMOKE CURER, J. Osgerby, London.
16,849. GALVANIC BATTERIES, G. A. Schoth, London.
16,850. LIFEBOAT DECK-SEATS, R. Pearson, London.
16,851. SHIPS' TABLES ROLLING STRIPS, G. Vaughan and J. J. Westacott, Newport.
16,852. KNEE MUSIC STAND, M. C. Stephenson, London.
16,853. PRODUCING ALUMINIUM, W. L. Wise.—(*The Schweizhische Metallurgische Gesellschaft of Lanffen.*)
16,854. DISINFECTING BEDDING, &c., W. E. Thursfield London.
16,855. WIRE ROPE, H. F. Solaini and H. W. Pugh, Liverpool.
16,856. FASTENERS for BELTS, P. Caldwell and J. H. Turner, Liverpool.
16,857. BICYCLES, G. W. Johnston, Liverpool.
16,858. VENTILATING SEWERS, &c., J. Smith, New Maldon.
16,859. ELECTRICAL ACCUMULATORS, C. D. Abel.—(*C. Zipernowsky, Austria.*)
16,860. PRODUCING ROTARY MOTION, A. V. de Byl, London.
16,861. DRAWING RODS, &c., A. E. and H. M. Butler, London.
16,862. AMALGAMATING AURIFEROUS SUBSTANCES, E. J. Ball and B. H. Brough, London.
16,863. ELECTRICAL CHARGE of BATTERIES, F. King, London.
16,864. WORKING RAILWAY SIGNALS, T. T. Powell, London.
16,865. LOCKING SCREW NUTS, W. S. Eaton.—(*S. H. French and W. J. Maltby, Texas.*)
16 866. INJECTING LIQUIDS into GAS RETORTS, R. Good, London.

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16,867. COAL SAVER, W. Greenwood, Bootham.
16,868. IMPLEMENT for MENDING LAWNS, D. Allport, London.
16 869. STOPPER for BOTTLES, B. C. Cross, Morley, near Leeds.
16,870. ELECTRO-DYNAMIC GENERATORS, R. Tatham, Liverpool.
16,871. PREVENTING ACCIDENTS in putting STRAPS upon PULLEYS, A. and G H. Hughes, Manchester.
16,872. RELIEF VALVES, R. Baird, Glasgow.
16,873. OIL LAMPS, G. Boyd, Glasgow.
16,874. POWER INCREASING GEAR for ENGINES, T. I. Moore, Birmingham.
16,875. UMBRELLAS and WALKING STICKS, F. C. Noar, Manchester.
16,876. SADDLES, F. C. Noar Manchester.
16,877 INTERMITTENT WATER DISCHARGE, H S. Maxim, London.
16,878. GRINDING CYLINDRICAL LENSES, F. Bright Birmingham.
16,879. SPRING SACKINGS for SHIPS' BERTHS, W. P. Hoskins, Birmingham.
16,880. TELEPHONIC CALL BOXES, A. E. Cotterell, Birmingham.
16,881. MATCH-STRIKING TABLET, J. H. Knight and A. T. Hollely, Sheffield.
16,882. MEANS for BURNING OILS, &c., J. Howie, Glasgow.
16 883 WEAVING, E. N. Molesworth-Hepworth, Manchester.
16,884. CLEANING and POLISHING TIN-PLATES, W. E. Koch, Cardiff.
16,885. HORSESHOES, W. and J. Simson, Glasgow.
16,886. POLISHING LINEN, &c., THREADS by means of PETROLEUM, J. Jackson, Sidcup.
16,887. CONDENSING STEAM, J. A. Rowe, North Shields.
16,888. SHOT for SPORTING GUNS, J. Bullough, Halifax.
16,889. VENTILATING FELT HATS, &c., R. Denison, Leeds.
16,890. BOTTLING BEER, &c., H. Finch, Orrell.
16,891. BRIDGES, E. W. Ives, Derby.
16,892. STRAINERS for EARTHENWARE TEA-POTS, J. Hollins and E. C. King, Longport.
16,893. BOOTS and SHOES, T. Wheelhouse, Halifax.
16,894. BLACKING, S. J. Cluff, Dublin.
16,895. STOPPING SPINNING, &c , MACHINES, H. Whitwam and H. Taylor, Halifax.
16,896. COMPOUND MOVABLE HYDRAULIC CRANE, C. R. Parkes, London.
16,897. CASINGS and FIXING of LOCKS to DOORS, L. W. Goold, Worcestershire.
16,898. DRESS IMPROVERS, C. A. White and F. T. Plester, London.
16,899. TWISTING, &c , YARNS or THREADS, T. Hale, Halifax.
16,900. FENDER STOOL, &c., M. W. Utting, Liverpool.
16,901. BOLT and LATCH, J. W. McCrossan, Liverpool, and P. Gill and T. Osman, Widnes.
16,902. COVER with GUMMED ATTACHMENTS, J. W. McCrossan, Liverpool, and P. Gill and T. Osman, Widnes.
16,903. STEAM GENERATORS, R. Panhard and E. Levassor, Paris.
16,904. SAFETY LAMPS, L. A. Groth.—(*J. Lotineaux, Paris.*)
16,905. FILTER, R. Gough London.
16,906. BREECH-LOADING FIRE-ARMS, L. A. Groth.—(*E. Sterzinger and F. von Stepsky, Austria.*)
16,907. INK BOTTLES, A. Dey, Glasgow.
16,908. FASTENINGS for BOLTS and NUTS, W. Armstrong, London.
16,909. PARALLEL and OFFICE RULERS, J. Eaton, London.
16,910. LIQUID GAUGE, G. H. Nash, London.
16,911. STRETCHING WOVEN PIECE GOODS, A. Birdtwistle, London.
16,912. SAFETY APPARATUS for HOISTS, H. P. Lavender, London.
16,913. BOOTS, T. Peel, London.
16,914. STEAM BOILERS, K. Gamper, London.
16,915. ELECTRICAL TRANSFORMERS, &c., J. G. Statter, London.
16,916. DISINFECTING WATER-CLOSETS, G. Smith, London.
16,917. WICK for BURNING OIL, J. Roots, London.
16,918. HEADING CARTRIDGE CASES, G. Greenwood, London.
16,919. DETONATORS, A. V. Newton.—(*A. Nobel, France.*)
16,920. EXPLOSIVE COMPOUND, A. V. Newton.—(*A. Nobel, France.*)
16,921. HOLDER for BOUQUETS, &c., G. W. Phippen, London.
16,922. FURNITURE RAILWAY, C. Clarke, London.
16,923. LABELLING BOTTLES, J. Nicloz and L. Merckling, London.
16,924. EXTINGUISHERS for LAMPS, B. J. B. Mills.—(*A Weisensee, Germany.*)
16,925. WEIGHING HAY, &c., W. Warner, London.
16,926. ELECTRO-DEPOSITION of METALS, T. Fenwick, London.
16,927. HYDRAULIC LIFTS, T. P. Ford, London.
16,928. CIGARETTES, P. Vauselle, London.
16,929. POST CARDS, &c., A. J. Boult.—(*R. de Denus, France.*)
16,930. FLOORS, ROOFS, &c., W. P. Thompson.—(*C. L. Gocht, Saxony.*)
16,931. CHIMNEY TOPS, J. Gowland, London.
16,932. HAND TRUCKS, J. and R. W. Kenyon and J. Barnes.—(*T. C. Massey, United States.*)
16,933. GAS LAMPS, A. J. Boult.—(*G. Lebrun and P. Fougiron, jun., Paris.*)
16,934. TELESCOPES, W. S. Simpson, London.
16,935. PRESERVING, &c., ANIMAL and VEGETABLE SUBSTANCES, C. Collin and L. Benoist, London.

*9th December*, 1887.

16,936. CORKS, J. Rixon, Elton.
16,937. HEAD WASHING, &c., APPARATUS, E. P. Purkis, Birmingham.
16,938. APPARATUS for TESTING FLUID GAUGES, E. F. Bamber, London.
16,939. SCREW PROPELLER SHAFTS, F. G. M. Stoney, Glasgow.
16,940. METAL BARS, C. M. Pielsticker, London.
16,941. REMOVING BLOW-HOLES from METAL, C. M. Pielsticker, London.
16,942. KNITTING FRAMES, R. H. Lendrum and D. Dytch, Halifax.
16,943. FITTING LIDS to METAL CANS, W. T. Seymour, Stockton-on-Tees.
16,944. DRAWING FLAX and other FIBRES, J. Barbour, Belfast.
16,945. AUTOMATIC SALE of SUNDRY ARTICLES, F. Isles, Birmingham.
16,946. RECORDING, &c., APPARATUS, H. Pooley, Liverpool.
16,947. FIRE-EXTINGUISHING SPRINKLERS, T. Witter, Manchester.
16,948. BREECH-LOADING ORDNANCE, G. Quick, London.
16,949. BREECH-LOADING ORDNANCE, G. Quick, London.
16,950. ORDNANCE, G. Quick, London.
16,951. WATER-TIGHT TANKS, CISTERNS, &c., E. Stiff, London.
16,952. EVAPORATING MOISTURE from TEA LEAVES, W. H. Gilruth, London.
16,953. GOVERNORS, G. Porter, London.
16,954. APPARATUS for EXTINCTION of FIRE, T. Birnbaum, London.
16,955. CUTTING COAL, T. and R. W. Bower, and J Blackburn, London.
16,956. SWITCH-BACK RAILWAYS, W. Hart and J. Ripley London.
16,957. TOWELLINGS, J. Haydock and W. Rossetter, London.
16,958. MACHINE for WINDING LACES, &c., C. Whitley, Birmingham.
16,959. ROLLERS for WINDING WIRE NETTING, W. P. Bullivant, London.
16,960. PIANOFORTES, E. W. and H. J. Norman, and G. A. W. Beard, London.
16,961. LAMPS for BURNING LIGHT OILS, A. H. Griffiths, London.
16,962. STAY SCREW, F. Rudall, Anerley.
16 963. CLOSING FANLIGHTS, SKYLIGHTS, &c., A. Illidge, London.
16,964. PRESERVATION of FISH, &c., A. R. Roosen, London.
16,965. WATER WASTE PREVENTERS, S. Nicholls and W. Cottrell, London.
16,966. REPRESSERS, G. Whitaker, J. Duncuft, and L. L. B. Williams, London.
16,967. MACHINES for COMBING WOOL, H. Wyman, London.
16,968. INDEX, A. Walter, London.
16,969. SMALL-ARMS, T. Bland and F. Cashmore, London.
16,970. TEA-POTS, E. C. Ribbans London.
16,971. MERRY-GO-ROUNDS or ROUNDABOUTS, T. Walker, Tewkesbury.
16,972. MIDDLE BITS for UMBRELLA RIBS, J. Edmonds, Birmingham.
16,973. SKATES, M. S. F. Monier-Williams, London.
16,974. COLOURING MATTERS, J. Imray.—(*La Société Anonyme des Matières Colorantes et Produits Chimiques de St. Denis, A. F. Poirrier, and R. Roussin, France.*)
16,975. CANAL LOCKS, A. L. Blackman, London.
16 976. TENONING MACHINES, S. Jones and R. Roberts, Liverpool.
16,977. CLUTCH ACTION, J. Kent, London.
16,978. CONNECTING PARTS of CASTORS, F. Davis, London.
16,979. TINNING of HOLLOW-WARE, T. Anderson, London.
16,980. REFRACTORY COMPOUND, F. V. Maquaire, London.
16 981. ATTACHMENT to BOTTOMS of TROUSERS, M. Wilson, London.
16,982. BURNERS for GAS LAMPS, G. W. Lamb, London.
16,983. TURNING LATHES, H. H. Lake.—(*W. Hoopes, United States.*)
16 984. ROTARY ENGINES, C. Griffin, London.
16,985. FILTERING WATER, E. T. G. Thorn, London.
16,986. PUMPS, E. B. Ellice-Clark and L. Chapman, London.
16 987. PRODUCTION of OXYGEN, &c., GASES, E. B. Ellice-Clark and L. Chapman, London.

*10th December*, 1887.

16,988. CARPET BEATING MACHINES, J. Smithers, Kingston-on-Thames.
16,989. WARMING and VENTILATING, A. H. Hobson and J. R. Croft, London.
16,990. ENLARGING DRAWINGS, C. Wells, London.
16,991. SPRING GUNS, C. Wells, London.
16,992. PIPE JOINTS, J. Grundy, London.
16,993. TAPPET SPANNER, J. H. Thomson, Erith.
16,994. MINER'S SAFETY LAMPS, J. Walls, Hindley Green, near Wigan.
16,995. CLOTH-LAYING MACHINES, G. Browning, Caldecott, Leicester.
16,996. CUTTING PILE FABRICS, J. H. Smith, A. Goddard, L. Higginbottom, and T. Mannock, West Gorton.
16,997. WATER-CLOSET CISTERNS, H. Parker and A. Winder, Birmingham.
16,998. BALE HOOP FASTENERS, J. Duxbury, Manchester.
16,999. DROP BOX LOOMS, C. Hahlo, C. E. Liebreich, and T. Hanson, Halifax.
17,000. VELOCIPEDES, W. Goulden, London.
17,001. TRUSSES, J. Ford, London.
17,002. CHECK PUNCHES, J. C. Lowdon, London.
17,003. TOBACCO PIPES, A. Dreyfus, London.
17,004. FLAMING LAMP, R. Robson, Low Wortley, near Leeds.
17,005. DOMESTIC FIRE-GRATES, H. Steven and J. Walker, Glasgow.
17,006. UMBRELLAS, &c., W. Ross, Glasgow.
17,007. CONVERTING GAS COKE, &c., into FUEL, J. Swallow and N. Procter, Leeds.

17,008. Pulmonic Embrocation, J. D. Polley, Belfast.
17,009. Steam Pile Drivers, J. Garvie, jun., London.
17,010. Railway, &c., Couplings, G. F. Priestley, Halifax.
17,011. Condensers for Carding Engines, T. H. Blamires, Huddersfield.
17,012. Lighting Tobacco Pipes, &c., A. Whitehead, Sheffield.
17,013. Pulleys, P. E. Ayton jun., Birmingham.
17,014. Velocipede Bell Attachments, J. B. Brooks, Birmingham.
17,015. Cut Nails, F. Hadley, Birmingham.
17,016. Valves for Water, &c , G. Nutter, London.
17,017. Combined Easel and Suspender, F. T. Jefferson, London.
17,018. Heat Radiators, J. Boyd, jun.. Glasgow.
17,019. Harrows, S. B. Goodwin, W. Barsby, R. Pochin, and A. Hill, Leicester.
17,020. Burglar Alarm, J. D. Dallas, London.
17,021. Locks and Keys, J. Kaye, Bradford.
17,022. Manufacture, &c., of Hosiery, H. Godkin, London.
17,023. Pianofortes, W. P. Thompson.—(*J. G. G. Schmidt, Germany.*)
17,024. Knitting Machines, A. J. Boult.—(*L. Herlitchka, Austria.*)
17,025. Operating Brakes, B. J. B. Mills.—(*H. Roberjot, France.*)
17,026. Steam Boilers, F. Godard and C. Petit, London.
17,027. Bookbinding, P. H. Newill, London.
17,028. Bracelets, J. Allday, sen., and J. Allday, jun., London.
17,029. Lubricators, J. M. Vanzini, London.
17,030. Measuring the Density of Vapours, J. G. Jourdan, London.
17,031. Regulation of Electric Currents, W. Lahmeyer, London.
17,032. Life-saving Apparatus for Tram-cars, R. Price and C. J. Nicholson, Birmingham.
17,033. Extracting Gold and Silver from Ores, A. Parkes, London.
17,034. Mounting Velocipede Saddles, W. Fisher and E. Redman, London.
17,035. Bending Tires, J. Davis, London.
17,036. Carrying, &c., Ingots of Iron and Steel, W. D. Allen, London.
17,037. Ingot Moulds, W. Robinson, London.
17,038. Mechanical Telephone Lines, W. H. Munns. —(*D. M. Monjo, United States.*)
17,039. Hat and Coat Racks, C. G. Udell London.
17,040. Cutter Head, J. G. Humphreys, London.
17,041. Gate Latch, T. Martin, London.
17,042. Car Axle Box, J. W. Cloud, London.
17,043. Bedsteads, W. W. Horn.—(*W. L. Drake, United States.*)
17,044. Carpets, H. B. Harris, London.
17,045. Railway Rolling Stock, E. Shergen, London.
17,046. Globes for Ceiling Lights, I. J. Collins, London.
17,047. Secondary Batteries, F. King, London.
17,048. Thrashing Machines, J. Marshall, London.
17,049. Separating Solids from Liquids, &c., I. S. McDougall and T. Sugden, London.
17,050. Sulphite and Bi-sulphite of Ammonia, W. H. Beck.—(*P. de Lachommette, France.*)
17,051. Automatic Coupling, E. Halot and O. Avedyk, London.
17,052. Fringing, &c., Fabrics, E. S. B. Boys-Tombs London.
17,053. Chairs, S. H. Bartram, London.
17,054. Steam Boilers, T. Lishman, London.
17,055. Locks, S. P. Wilding.—(*C. J. Kintner and — Herzog, United States.*)
17,056. Locks, S. P. Wilding.—(*C. J. Kintner and — Herzog, United States.*)
17,057. Locks, S. P. Wilding.—(*C. J. Kintner and — Herzog, United States.*)
17,058. Locks, S. P. Wilding.—(*C. J. Kintner and — Herzog, United States.*)
17,059. Finishing the Bore of Rifled Guns, M. Gledhill, London.
17,060. Boring Machines, M. Gledhill, London.

*12th December*, 1887.

17,061. Candle Shades, D. J. Proctor, London.
17,062. Organs, E. H. Suggate, London.
17,063. Grinding Glass Stoppers, C. Emmet, Leeds.
17,064. Gearing, S. Eddington and J. E. Steevenson, Chelmsford.
17,065. Superheating Steam, S. Eddington and J. E. Steevenson, Chelmsford.
17,066. Printing Gold, &c , Decorations, M. Ehrlich and C. Storck, Berlin.
17,067. Connecting Parts of Mattress Frames, &c., I. Chorlton and G. L. Scott, Manchester.
17,068. Shuttle-box Motion of Looms, J. Swallow and J. A. Sykes, Halifax.
17,069. Ventilating of Mines, J. Taylor and W. Whitfield, Monkwearmouth.
17,070. Shaft Couplings, C. F. Cockshott and J. E. Jowett, Bradford.
17,071. Egg Boilers, J. L. Garsed, Halifax.
17,072. Raising Beer, J. and R. G. Rae, Glasgow.
17,073. Soda and Ammonia Salts, W. Mason and C. J. Whittaker, Accrington.
17,074. Attaching, &c , Lamps, S. C. L. Fuller, Bath.
17,075. Tool for Opening Cans, W. R. Goulty, Manchester.
17,076. Syringe Washing Machines, J. McDermott, Glasgow.
17,077. Regulating the Backing-off Motion in Mules, J. Hope, London.
17,078. Securing Handles in Candlesticks, F. Rose, Liverpool.
17,079. Slide Valves, W. Glover, Liverpool.
17,080. Velocipedes, W. C. Burton, Rochdale.
17,081. Valves for Furnaces, H. Le N. Foster, Stockton-on-Tees.
17,082. Foundations for the Cards used in Carding, J. Crossley and W. Healey, Manchester.
17,083. Sliding Canopy Stoves, C. H. Perrot and A. Habershon, Rotherham.
17,084. Foot-warmers, J. W. Boughton, J. W. H. Turner, and H. F. Boughton, Hanningley, near Barnsley.
17,085. Centrolinead Protractor, M. C. Williams, Carlisle.
17,086. Dollying Mechanism, J. Greenwood, Keighley.
17,087. Automatic Delivery of a Fluid, G. C. Bingham, London.
17,088. Water-tight Joint for Drain Pipes, A. B. Crombie, London.
17,089. Cores of Armatures of Electro-motors, M. Immisch, London.
17,090. Pipes for Smoking, C. Cayton, London.
17,091. Bottles, H. A. Leverett, London.
17,092. Revolving Weather-protecting Game Coop, E. R. Plowman, Crayford.
17,093. Feed-water Heaters, J. Gill, London.
17,094. Spiked Appliances for Reducing Superphosphates, &c., H. D. Salomonson and J. Laubheimer, London.
17,095. Packing of Acids, W. White and A. Rickman, London.
17,096. Materials for Paper-making, W. Black and W. L. Rennoldson, London.
17,097. Cleaning Lithographic Printing Stones, G. S. Willis and G. M. Willis, London.
17,098. Uncapping, &c., Sporting Cartridge Cases, J. Evans, London.
17,099. Hollow Comb for Supplying Oil to the Skin without Wetting the Hair, A. Mudie, London.
17,100. Substitute for Glass for Ornamental Purposes, F. J. Vergara, London.
17,101. Elastic Diaphragms for Pressure Gauges, C. W. F. Struck, London.
17,102. Bleaching, &c., Cloth, &c., G. A. Schleber, London.
17,103. Tanning, E. I. Lanvin-Schraen, London.
17,104. Fastener for Labels, &c., P. Trémoulière, London.
17,105. Manufacture of Castings, C. and A. L. Taverdon, London.
17,106. Dyeing Cotton, &c., J. Grunhut, London.
17,107. Opera, &c., Glasses, W. A. Cardwell, London.
17,108. Motor Engines, C. D. Abel.—(*The Gas Motoren Fabrik Deutz, Germany.*)
17,109. Ring Spinning and Doubling, O. Imray.—(*A. S. J. Miron and T. E. Wilson, France.*)
17,110. Compass Cards, H. H. Lake.—(*C. C. Plath, Germany.*)
17,111. Casting Hollow-metal Ingots, M. Gledhill, London.
17,112. Composition for Kindling Cotton Wick, H. H. Lake.—(*P. Fourneir, France.*)
17,113. Anti-friction Bearings for Car Trucks, &c., S. P. Wilding.—(*W. J. Brewer, New York.*)
17,114. Fastenings for Bags, Boots, &c., J. Keats, London.

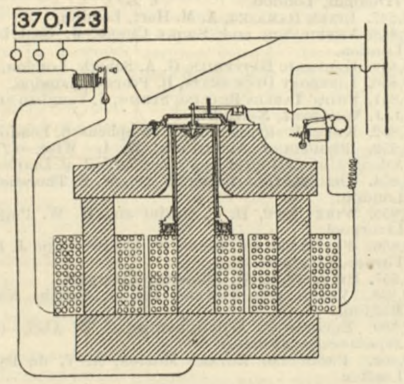
## SELECTED AMERICAN PATENTS.

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

**370,123.** Electric Meter, *T. A. Edison, Menlo Park, N.J.—Filed April 17th*, 1883.

*Claim.*—(1) In an electrical meter, the combination, with indicating or registering apparatus, of an electro-dynamic motor operating such indicating or registering apparatus and having its inductive portion in the translation circuit, the electrical energy consumed in which is to be measured, and a multiple arc circuit including the field coils of such motion, substantially as set forth. (2) A mono-electro-dynamic motor, in combination with means for giving such motor a definite loading, and means for varying such load, to compensate for variations in proportionate friction, substantially as set forth. (3) In an electrical meter, the combination, with indicating or registering apparatus, of an electro-dynamic motor located in the translation circuit, a multiple arc circuit including the field-of-force coils of such motor, and means located in the translation circuit for opening and closing such field circuit when the last translating device is removed from circuit and the first one placed in circuit, substantially as set forth. (4) In an electrical meter, a

370,123

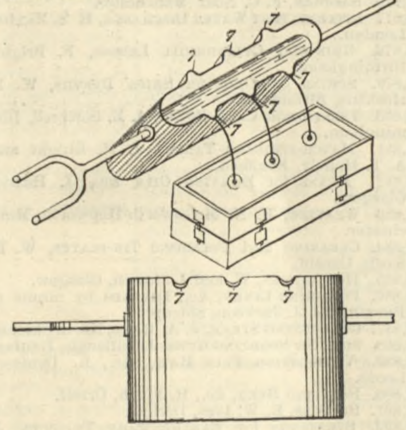


non-commutator electro-dynamic motor provided with a single or straight inductive portion, and having the opposite poles of its field magnet brought together on opposite sides of such inductive portion, in combination with a register operated or controlled by the motor, substantially as set forth. (5) In a mono-electro-dynamic motor forming the operative part of an electrical meter, the revolving cylinder forming the inductive portion of the motor, in combination with a register operated or controlled by the motor, substantially as set forth. (6) In a mono-electro-dynamic motor forming the operative part of an electrical meter, the combination, with a centrally-located pole and a surrounding pole, of a revolving cylinder mounted upon the centrally-located pole, and a register operated or controlled by the motor, substantially as set forth.

**370,159.** Moulders' Pot, *R. A. Register, Baltimore, Md.—Filed November 19th*, 1886.

*Claim.*—A moulder's device for pouring molten metal, provided on one or both sides with two or more spouts 7, the said spouts 7, which are on the same side, being equidistant from a longitudinal line drawn centrally through the said device, in combination with a

370,159

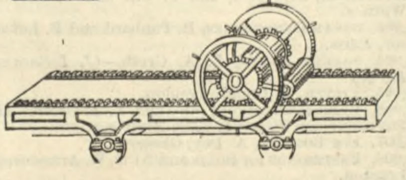



mould having two or more gates registering with the spouts in the ladle and opening into the cavity of the mould, by which, when the device is tilted, the streams of molten metal will flow from each spout in the same plane and simultaneously into the respective gates, for the purpose set forth.

**370,177.** Apparatus for Rolling Glass, *A. D. Brogan and A. M. Malloch, Firhill, Glasgow, Scotland.—Filed March 14th*, 1887.

*Claim.*—(1) In an apparatus for rolling glass, the combination, with the table and the main roller adapted to traverse the surface of the glass, of an auxiliary roller movable vertically independently of

370,177

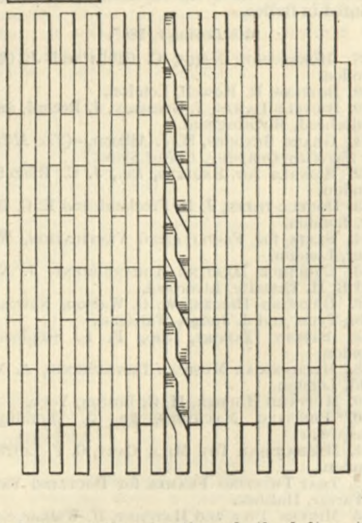


the main roller and adapted to follow in its wake, substantially as set forth. (2) The combination, with the table and the main roller adapted to traverse the surface of the glass, of an auxiliary roller and links connecting said rollers, whereby one is adapted to rise and fall independently of the other, substantially as set forth.

**370,237.** Driving Belt, *F. B. Brock, Washington, D.C.—Filed April 13th*, 1887.

*Claim.*—A driving belt composed of longitudinal sections, a series of connecting flexible links overlapped at the ends, and a series of pins inserted alter-

370,237

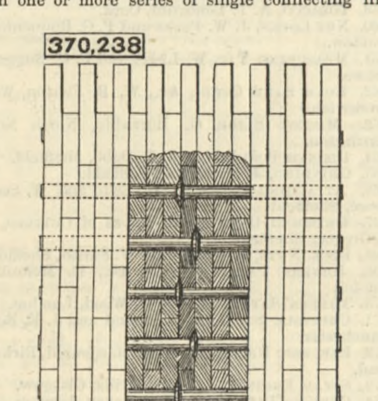


nately from opposite sides through the belt sections and through alternate ends of the connecting links, substantially as set forth.

**370,238.** Driving Belt, *F. B. Brock, Washington, D.C.—Filed May 16th*, 1887.

*Claim.*—A driving belt composed of parallel sections, each comprising a series of links immediately adjacent to each other the full width of the belt, and provided with one or more series of single connecting links

370,238

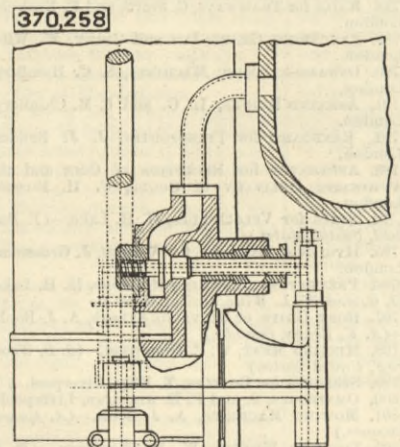


lying adjacent to the belt sections, and a series of pins passed through the sections and through opposite ends of said connecting links alternately from opposite sides thereof, substantially as set forth.

**370,258.** Gas Motor Engine, *H. P. Holt, Leeds, and F. W. Crossley, Manchester.—Filed November 6th*, 1886.

*Claim.*—(1) In a gas motor engine, the combination of a check-valve with a movable cam, whereby the valve may, when required for starting the engine, receive movements suitable for the admission of compressed fluid from the reservoir to the cylinder, substantially as described. (2) The combination of a regulating valve controlled by a cataract with a

370,258

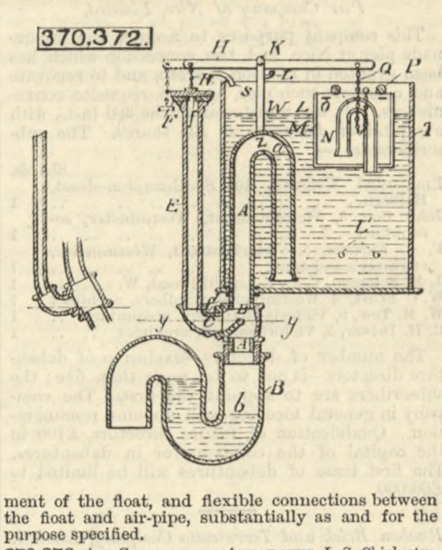


collapsible bag on a supply pipe of a gas motor engine, as and for a purpose herein set forth. (3) A weight for governing a gas motor engine, suspended to a reciprocating part, which weight, when the speed is excessive, by its inertia causes the reciprocating part to miss opening the gas supply valve, substantially as herein described.

**370,372.** Reservoir or Tank, *D. W. Brown, New York, N.Y.—Filed March 6th*, 1886.

*Claim.*—(1) The combination of a reservoir or tank, a syphon therein, an automatic seal to the syphon, an air pipe communicating with the said syphon, a valve on the said air pipe, an automatically-filling cup or float in the reservoir, provided with a syphon for automatically emptying it, a stop to limit the upward movement of the float, and flexible connections between said cup and valve, substantially as and for the purpose specified. (2) The combination, with the reservoir T and syphon A, of the air pipe E, having the automatically-operated valve and the lateral branch C, connected to the syphon, and having aperture *d d*, and lip D, substantially as described. (3) The combination, with the reservoir T and syphon A, of the air pipe E, having the lateral branch C, connected to the syphon and extending partially below the line of juncture with the same, substantially as and for the purpose set forth. (4) In combination, the reservoir T, cup M, with syphon N, stops P P, chain Q, lever H, valve G, air pipe E, syphon A, and trap B, arranged to operate substantially as described. (5) A tank provided with a syphon outlet, an automatically-operated air inlet to the syphon, an automatically-sealed outlet to the syphon, an automatically filling and emptying float, a stop which limits the upward move-

370,372

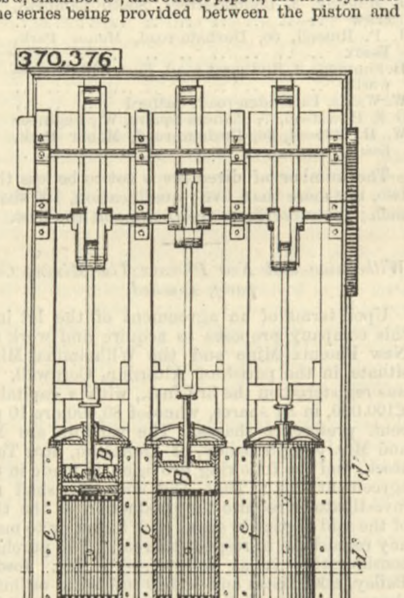



ment of the float, and flexible connections between the float and air-pipe, substantially as and for the purpose specified.

**370,376.** Air Compressing Apparatus, *L. S. Chichester, Newark, N.J.—Filed November 1st*, 1886.

*Claim.*—In an air compressing apparatus, the combination, with a series of compressing cylinders each formed entirely open at one end to permit the circulation of the atmosphere therein, of a piston with its piston-rod extending from the open end of the cylinder, a cooler casing, *c*, extending from the opposite end of the cylinder and in continuous metallic connection therewith, and provided with the tube plates *b b*[1], tubes *d*, chamber *a*[1], and outlet pipe *h*, the first cylinder of the series being provided between the piston and

370,376



the inner ends of the cooling tubes with a partition and cooling plate, *f*, having an aperture and valve, *g*, opening toward the ends of the tubes, and the pipes *h*, being connected respectively, with the inlets of the succeeding cylinders and being provided with weighted or adjustable check valves, as *l l*[1], and the whole being arranged and operated as and for the purpose set forth.

**370,398.** Tire-heating Furnace, *R. A. Lewis, Cherokee, Iowa.—Filed January 29th*, 1887.

*Claim.*—(1) The tire-heating apparatus composed of a ring form bottom plate having apertures therein, concentric cylinders forming the walls of the chamber, and sectional covers, and benches or supports across the interior of the chamber, between the walls thereof, and supports secured to the bottom plate, in combination with a gas-burning apparatus composed of a line of piping passed through bearings 11 in flanges carried by the supports of the chamber, and having a number of pipes projected therefrom into the chamber and terminating in burners, whereby the supports are

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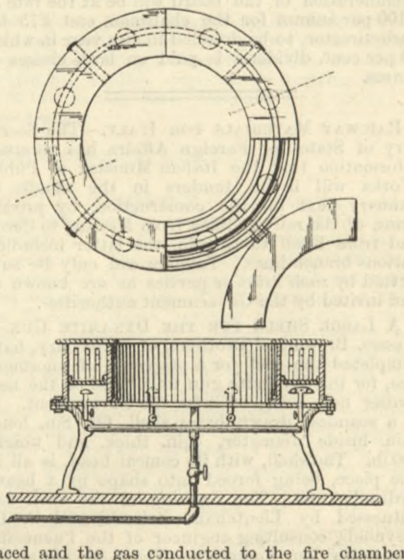

braced and the gas conducted to the fire chamber, substantially as specified. (2) The combination of a tire-heating chamber, provided with supports, with a line of gas pipe fixed rigidly to said supports, and pipes terminating in burners projected from said line of gas pipes into the tire-heating chamber, and a feed pipe opening into the pipe held by the support, substantially as described, and for the purpose stated.

New Railway in India.—The Patiala Regency has agreed to construct 100 miles of a broad-gauge railway from Patiala to Bathinda. The Punjab Government will carry out the work, which it is expected will cost about Rs. 80,000 a mile.