EXPERIMENTS WITH A CORLISS ENGINE AT CREUSOT.

As it cannot for a moment be urged that we know all that it is necessary should be known concerning the performance of steam in an engine, we condense from our contemporary, *Annales Industrielles*, a report on a series of interesting experiments carried out with a Corliss engine at Creusot. It will be seen as we proceed that the conditions of the trial were in may respects unusually favourable for obtaining an accurate result. The Corliss type of engine enjoys such a high reputation as an economical motor that it may be assumed that the steam was used under conditions certainly not unfavourable to economy. If the results obtained are opposed to the theories of a few *doctrinaires*, so much the worse for the latter.

The engine in question was constructed with the greatest possible care at the Creusot Works. The cylinder is 22in. diameter, with a stroke of 3ft. 7½in. The space swept by each stroke of the piston is 9 cubic feet and 71 cubic inches. The various pipes about the cylinder are all jacketted, with external casings of cast iron. The clearance is as small as possible, and was measured by putting the crank on the dead point and filling the clearance space with water through the indicator cock holes. At the front end of the cylinder it was found to be 3·58 per cent., and at the back end 3·74 per cent. of the volume swept per stroke by the piston. The body only of the cylinder is jacketted, and a cock is provided by which steam may or may not be admitted to the jacket. There is a proper discharge pipe provided for draining the jacket. Outside the steam jacket is an air jacket made of sheet iron. The engine can be worked condensing or non-condensing at pleasure, a valve being fitted in the exhaust pipe for the purpose.

The engine drove a brake, very carefully and specially constructed for the purpose of these experiments. Steam could be had either from the special boiler set apart for the trial, or from a main steam pipe traversing a portion of the works, and supplying several steam engines. During the experiments the engine was always started and run until it was properly heated up, with steam from the main; but at the instant of beginning a test run, a valve was briskly shifted, and, without the loss of a moment, the supply from the main was cut off and that of the special boiler was turned on. As, up to the time the valve was thus shifted, the water was comparatively still in the trial boiler, its level was obtained with great exactness, unaffected by any lifting or frothing which might take place when steam was being drawn off. When the experiment was over, the valve being shut, the boiler was filled up to the original level.

Two Martin indicators were fitted one to each end of the cylinder, and driven by a large pulley placed between them, and put in motion by a brass wire hard enough not to stretch and always in tension. The speed of the pulley bore a constant relation to that of the piston. A special device was used by which the indicators could be thrown into or out of action in a moment. The brake resembled in its general principle that used by the Royal Agricultural Society, and familiar, no doubt, to our readers.

In carrying out the experiments the engine was run for about an hour, when steam was quickly shut off, and the brake rapidly brought the engine to rest; the number of revolutions was noted, and the boiler was then fed up to its original level, two large injectors being used for this purpose, so that no time was lost. Two measuring tanks were used, the water flowing from one into another, from which the injectors drew. The distance through which the water fell in the first tank was noted, and in this way the quantity of feed-water used was arrived at. The diagrams were calculated by Amsler's planimeter.

The engine was made to work under various conditions. Table 1 shows some of the results obtained.

TABLE I.

Without Condensation; without Steam Jacket.

Number of experiment.	Duration of trial in minutes.	Initial pressure by the diagrams. kilogs.	Percentage of admission.	Vacuum in centimetres of mercury.*	Number of revolutions per minute.	Horse-power.		Consumption of steam, kilogs.		
						Indicated.	Effective.	Total.	Per I.H.P. per hour.	Per effective H.P. per hour.
Boiler Pressure, 110 *lb.*										
1	60	6·775	0·04	69	60·0	110·4	84·5	1146	10·40	13·60
2	105	6·947	0·06	69	58·6	130·3	101·8	2271	9·95	12·75
3	75	7·027	0·09	68·5	59·4	163·0	130·4	1952	9·58	11·97
4	36	6·970	0·125	68·5	57·7	189·0	154·0	1115	9·84	12·07
Boiler Pressure, 80 *lb.*										
5	120	5·610	0·075	69	59·8	127·8	98·7	2426	9·48	12·29
6	100	5·700	0·083	69·5	59·3	136·0	106·1	2132	9·42	12·11
7	90	5·633	0·105	69	59·8	152·0	120·2	2121	9·30	11·73
8	55·5	6·015	0·140	69	58·0	177·0	145·0	1455	8·90	10·84
9	50	5·960	0·180	67·5	59·1	197·0	163·4	1500	9·14	11·00
Boiler Pressure, 62 *lb.*										
10	91	4·250	0·059	71	58·3	86·5	62·0	1200	9·13	12·58
11	90	3·925	0·090	70	59·5	116·2	89·5	1488	8·54	11·09
12	75	4·300	0·155	70·5	59·0	151·8	123·0	1535	8·08	9·97
13	75	4·100	0·227	70	58·3	174·0	145·8	1790	8·22	9·82
14	31	4·360	0·250	69	59·2	188·2	158·5	820	8·43	10·01
Boiler Pressure, 47 *lb.*										
15	70	3·165	0·060	71	60·7	76·6	52·8	826	9·24	13·40
16	80	3·440	0·095	71·5	58·8	95·6	71·2	1105	8·66	11·62
17	111	3·370	0·150	70	60·4	121·8	96·1	1891	8·40	10·63
18	54	3·360	0·210	70	58·8	142·0	124·4	1086	8·50	10·64
19	55	3·348	0·290	69	59·4	167·7	135·8	1360	8·85	10·92
Boiler Pressure, 32 *lb.*										
20	85	2·33	0·182	70·5	60·3	not	80·3	1387	9·15	12·18
21	48	2·44	0·430	67·5	61·1	accu-	134·2	1876	10·17	12·32
22	62·5	2·55	0·567	66	61·0	rately	154·0	1462	11·30	13·40
23	20	2·23	admission during the whole stroke	64	60·0	stated	184·5	161·7	987	16·05	18·33

* 76 centimetres are very nearly 30in.; 69 centimetres are 27·1in.; 71 centimetres are 28in. nearly.

Our readers will not be slow in drawing their own deductions. We may, however, call attention to the circumstance that the greatest economy was obtained in experiment No. 12, when the weight of steam used was 8·08 kilos., or 17·62 lb. per indicated horse-power per hour, while the highest was in the twenty-third experiment brought to an early termination because steam enough could not be got out of the boiler, when the quantity reached over 35 lb. per indicated horse-power per hour. In this case steam of only 32 lb. pressure above the atmosphere was worked full stroke. In experiment No. 12 the steam was admitted for 22·7 per cent. of the stroke, or nearly one-fourth, the pressure being 62 lb. We question if a greater degree of economy has ever been obtained with a non-condensing unjacketted engine. But it must not be forgotten that the French horse-power is less than the English, which fact must be allowed for in forming a comparative estimate of the results obtained.

In another impression we shall show what results were obtained with jacketting and condensation. We have not space to give the tables here. It must suffice to say that the best result—obtained in trial No. 26—was a consumption of 7·38 kilogrammes, or nearly 16·5 lb. of steam per horse per hour, with a pressure of 110 lb., steam being admitted for 6·7 per cent., or a little more than one-fifteenth of the stroke. If we compare this with run 12, it will be seen that by raising the pressure from 62 lb. to 110 lb., turning steam into the jacket, and using condensation, a saving was effected of a little over 1 lb. of steam per indicated horse-power per hour. Whether this is worth having at the price seems to be an open question.

(To be continued.)

THE BLAAUW KRANTZ VIADUCT IN CAPE COLONY.

No. I.

THIS viaduct is built over a rocky ravine on the railway from Port Alfred to Grahamstown, at a height of about 200ft. from the bottom. Its length is 480ft. 6in., and the width of the platform is 15ft., the gauge of the railway being 3ft. 6in. The central span of the viaduct is an arch of 220ft. span between abutments and about 90ft. height; the remainder of the space on each side is divided into two spans by an iron pier at a distance of 68ft. from the retaining wall. These piers are 36ft. 2in. high and carry girders 144ft. long, balanced each on a pivot in the centre. One end of these girders is secured to the retaining walls by means of horizontal and vertical anchorages, while the other end rests in a sliding bearing on the top flange of the arch.

In designing the structure the following points had to be considered:—(1) That, on account of the great height above the ground and on account of the high price of timber at the site, the structure could be easily erected without the use of scaffolding supporting it as a whole. (2) That, on account of the high freights to Port Alfred, the quantity of iron in the structure should be as small as possible. (3) That the single parts of the principal spans should be easy to lift, and that there should be as few of them as possible. For this latter reason most of them were made in lengths of 20ft. and more. The question of economy of material presented itself as a comparison between a few standard types, viz., the girder bridge of small independent spans; the cantilever bridge or the continuous girder bridge in three large spans; the single girder bridge with one large span and several small spans; and the arch with small girder spans on each side. The suspension bridge was left out of question as inadmissible. A girder bridge with small independent spans on rocker piers would probably have been the most economical, even taking into account the great height of the piers near the middle of the ravine, but there would have been some difficulty in holding those piers in position until they could be secured to the girders at the top; and, moreover, such a structure would have been strikingly out of harmony with the character of the site. On the other hand, a cantilever or continuous girder bridge in three spans—although such structures have been erected in similar localities—could not enter into comparison of simple economy of material, because such a design would entirely disregard the anomaly that the greater part of the structure, viz., the side spans, being necessarily constructed to carry across a large space, would be too near the ground to justify the omission of further supports. The question was, therefore, narrowed to a comparison between the present arch and a central independent girder of the same span, including the piers on which it rests. The small side spans could obviously be left out in each case. The comparison was made with a view not only to arrive at a decision in this particular case, but also of answering the question of the economy of the arch more generally. The following table contains the weights of geometrically similar structures of three different spans, of which the second is the one here described. The so-called theoretical weight is that which the structure would have if no part required stiffening, leaving out also all connections and all wind bracing. The moving load is taken at one ton per foot lineal, and the strain on the iron at an average of four tons per square inch. The proportion of the girder is taken at 1 in 8.

Span in feet.	Theoretical weight.		Total weight.	
	Arch.	Girder.	Arch.	Girder.
100	0·0724	0·1663	0·1866	0·2443
220	0·1659	0·4109	0·4476	0·7462
300	0·2414	0·6445	0·6464	1·2588

Tons per foot lineal.

It can be seen from these results that the economical advantage of the arch increases with the span. In small arches this advantage would not be large enough to counterbalance the greater cost of manufacture; but in the arch of 220ft. span the advantage is already very marked. If the table were continued, it would show that the girder, even if the platform were artificially widened, would become impossible at a point where the arch can still be made without difficulty. The calculations leading to the above results would occupy too much space to make it desirable on this occasion to produce them, and it will be necessary to resume the description of the viaduct, two views of which, taken from photographs, will be found on page 165.

THE POWER EXPENDED IN ELECTRIC LIGHTING.

By GISBERT KAPP.

THE power required for driving the dynamo is generally a very important item in the total cost of working an electric light installation. Whether it be the most important item depends on the number of lighting hours per annum, on the limits between which the load varies, and in the case of incandescent lamps also on the candle power they are worked at. To press the lamps hard so as to work them over their normal degree of incandescence results in a considerable increase of light, with but a slight increase of power, and must therefore produce an economy in the annual coal-bill; but, on the other hand, the expense for lamp renewals would be considerably increased. It is interesting to note that those conditions which tend to reduce the total cost of working an installation, viz., long hours, a moderate pressure on the lamps, and a fairly constant maximum load, tend at the same time to enhance the importance of the item of power in the total cost. Now in electric light installations for industrial purposes, as for instance, in the lighting of docks, yards, factories, mills, and workshops, we generally have long hours and a fairly constant load, the two conditions which make the cost of power the most important part of the total cost; and engineers will naturally ask how much power must be provided, how much of it will be wasted, and how much of it will be transformed into light.

The waste occurs throughout the whole system at every step of transmission or transformation of energy. There is a loss of power within the engine, the actual horse-power of which is always smaller than the indicated horse-power; there is a further loss in the gear by which the power is transmitted to the dynamo. In the dynamo itself there are several distinct losses which are necessary accompaniments of the transformation of mechanical into electrical energy, and the wires which carry the current to the lamps are heated by it, and this heat has to be paid for by an increased consumption of fuel under the boiler. In the case of arc lamps a slight loss occurs in the lamp itself, by reason of the electrical energy required for the proper control and "feed" of the lamp.

About the loss of power in the engine and gear it will not be necessary to speak at length. It is of the same nature as usually found in all kinds of machinery, and engineers are able to estimate it for any particular case with great accuracy. Not so with the dynamo. Here the causes of loss of power are neither generally known nor easily traceable, and very astounding statements have at various times been put forward by makers of dynamos, or by other interested parties, without it being possible to easily verify or refute such statements. But when we are told that some machines return an electrical energy of from 92 to 95 per cent. of the mechanical power put into them, we may well doubt the accuracy of the statements or of the tests by which such figures were obtained.

When a dynamo is at work the external wires on the

armature is being moved rapidly along and within a very small distance from the polar surfaces of the field magnets experience a resistance which is the greater the stronger the magnetic field, the quicker the speed, and the greater the current. The energy represented by the product of this resistance into the speed of rotation is transformed into internal electrical energy, which can be expressed by the product of current and internal electro-motive force. In a perfect machine this ought to equal the power applied to the spindle of the armature, but in reality more has to be applied, because some power is required for the mechanical friction in the journals, for churning the air, and for an additional electro-magnetic resistance which can best be described by the term "magnetic friction." A simple illustration of this kind of friction is the well-known experiment of Foucault, which shows that considerable power is required to spin a metallic disc in the neighbourhood of a magnet. The iron core of the armature which is revolving between two very intense magnetic poles is subject to a similar friction. To minimise the evil this core is not made in one solid piece, but consists of iron wire or thin iron discs more or less insulated from each other, especially on the outer periphery. But in spite of this subdivision some small amount of energy is always consumed, and is returned to us in a very undesirable form, namely, in heat, which must be carried off by radiation and convection, so that the insulation of the wires may not be injured. In the case of ring or disc machines, the core is supported by metallic spokes, which, for mechanica reasons, cannot well be made with insulated subdivisions; but as these spokes are more or less shielded from the direct influence of the magnetic poles by the intervening core, they are not so likely to become heated on that account, provided the core be so thick as to act as an opaque screen to the lines of force of the field-magnets. The spokes become, however, heated to a slight degree from a different cause, which can be explained as follows: The core of the armature, when a current is passing through its coils, becomes itself an electro-magnet, the poles of which stand about at right-angles to the poles of the field magnets. In this manner, what is technically called a secondary field is produced, and this remains fixed in space although the armature revolves. Now the metallic supports of the core must cut through the magnetic lines of force of this secondary field, and in so doing experience a certain amount of magnetic friction, even if—as should always be the case in a properly-designed machine—they completely escape the lines of the primary field. In the modern drum armatures of the Siemens, Edison, or Weston type, a similar action takes place, but to a lesser degree, because the only solid part of the armature is the spindle, the diameter of which is, of course, much smaller than the internal diameter of a ring armature. Some of the original Edison machines were, however, very defective in this respect, three longitudinal bolts being used to hold the discs of the armature core together, and to this arrangement must be ascribed the fact that these original machines were so heavy to drive. As will be seen from the table given below, an Edison machine tested at the Munich Exhibition absorbed not less than 34 per cent. of the total power in mechanical and magnetic friction, whilst the modern machines of the Edison-Hopkinson type are said to absorb less than a third of this. Of the total electrical energy created in the wire coils of the armature a certain proportion only is received at the commutator, where the brushes take the current off, the remainder being lost through electrical resistance. The lower this resistance the better, and in this respect an enormous improvement has within the last year or two been made by nearly all the manufacturers of dynamos. It was at one time thought necessary to multiply the number of convolutions on the armature, in order to get up the required electro-motive force, and thus the resistance of the armature was not only high, but it also had a large coefficient of self induction, causing considerable sparking at the brushes, which involved an additional loss of power. Now electricians have learned how to obtain a high electro-motive force by simply putting plenty of iron into the armature and employing a smaller number of convolutions with a proportionate reduction of resistance, and having the additional advantage of perfect freedom from sparking. Both these results are attended by a considerable saving of power. The latest published test of an Edison-Hopkinson dynamo shows a loss in the armature of only 4·4 per cent. of the total electrical energy developed, and other machines are equally good in that respect, as will be seen from the tables given below.

Not all the electrical energy flowing from the commutator into the brushes is available for external use. Part of it has yet to be sacrificed for producing the magnetic field. How large a part depends on the type and design of the machine, on its size and on the quantity and quality of the iron forming the magnet cores. The latter point is of great importance. Iron of the softest quality and plenty of it is the secret by which this loss can be made very small. The author has found that cast iron magnets require from 2 to 2½ times as much exciting power as magnets of soft Swedish wrought iron thoroughly annealed. The loss of energy in exciting the field magnets varies between 2½ and 15 per cent. of the total electrical energy developed. After deducting these various losses we obtain the energy actually available for external work, or, as it is technically termed, the "electrical output." Considering the large number of various dynamos in the market, good, bad, or indifferent, it is quite impossible to lay down a general rule as to the power required to give a certain electrical output, and the above remarks are therefore more intended to show what kind of losses take place than to fix actual numerical values to each. But to make this article of some use to practical engineers, some tables are given below containing results obtained with different machines. It is much to be regretted that neither the jury of the Vienna Exhibition, nor that of last year's Health Exhibition, have as yet published their report on dynamos; and thus we are forced to fall back on the Munich tests as the only available authoritative record of the performance of various dynamos. Unfortunately, some of the machines tested at Munich have already become nearly obsolete, and we have to rely on private sources for information regarding the modern dynamos. But in spite of its antiquity, the Munich report has considerable interest—partly because many hundreds of machines similar to those tested are now in use, and are likely to remain in use for many years—for dynamos hardly ever wear out—and partly because it serves to show the progress made in dynamo-construction within the last two or three years. The report on the Munich tests contains a number of very minute tables, the reproduction of which would be quite out of place in a short article like the present; but to save the reader the trouble of wading through a maze of figures, a short abstract containing average values is given below. All the figures are percentages of the total horse-power transmitted into the dynamo. The first column gives the loss of power due to churning of air, to mechanical friction of journals, and to magnetic friction; the second column gives the loss in armature; the third the loss in exciting the field magnets; and the fourth the actual electrical output:—

Type.	Friction.	Armature.	Field.	Output.
Edison ...	34·00	2·76	5·80	57·44
Bürgin ...	9·25	13·75	12·20	64·80
Schwerd ...	13·50	6·95	11·05	68·50
Schuckert ...	7·90	9·15	10·90	72·05
Schuckert ...	19·20	8·30	9·90	62 60

From this table it appears that with the older form of dynamo an average output of about 65 per cent. is obtainable. In modern machines the percentage recovered varies between 70 and 80, and in some exceptional cases it may reach as high as 85 per cent. Experiments which the author has made with some Crompton dynamos have shown an output of about 80 per cent. of the power applied, and other modern machines are probably equally good. As an example may be cited the Schuckert-Mordey dynamo, a test of which, kindly forwarded to the author by Mr. Mordey, is given below.

The machine tested was a D_2 Victoria compound dynamo, driven through a White's transmission dynamometer, which indicated 11·2 horse-power.

Horse-power given out in external circuit	9·480	or 84·2	per cent.
Horse-power lost in armature	·512	or 4·6	,,
Horse-power lost in series coils on field magnets	·393	or 5·2	,,
Horse-power lost in shunt coils on field magnets	·187		
Horse-power lost in magnetic and mechanical friction	·628	or 6 0	,,
Total	11·2		

This is an exceptionally good performance, and it is probable that the machine working at any other speed or output would have shown a somewhat lower efficiency. But within reasonable limits, we may safely take it that it will yield in electrical output about 80 per cent. of the power applied.

Whether large or small dynamos are more economical has long been a moot point with electricians, but at present the balance of opinion is rather in favour of large machines. From a number of trials the author has made with Crompton machines for sixty and 200 lights the following average figures have been obtained, giving the loss in percentage of the total electrical energy:—

Loss in armature ...	14 00,	60 lights ...	3·55, 200 lights.
Loss in field magnets.	12·50 ,,	...	3·90 ,,

These losses are, however, considerably influenced by the speed of the machine. It will be evident that the slower the machine runs the larger must it be to produce a given electrical output; and since it must take more energy to excite a large magnet as compared to a small one, we must expect to find a greater loss in slow speed machines. Experience confirms this, and in the case of a 350-light machine running at only 500 revolutions per minute, the loss was found to be—in armature, 5·65 per cent.; in field magnets, 5·42 per cent. By the courtesy of Mr. Crompton, the author is able to give below the results of some tests made at the Victoria Central Station. There are two large dynamos worked by belts from a countershaft on the first floor and two vertical compound engines on the ground floor, which drive the countershaft by belts from the fly-wheel and through two friction couplings. Only one of the engines is at work at a time, the other being in reserve. At present the engines are not fully loaded, and hence the following table of power test should only be considered as a preliminary one; but the author has thought it better to give the tests, incomplete though they be, because information of this nature is generally very difficult to obtain. The trial extended over three days; on the first the speed of the engine was about 150 revolutions, and since the load was only light the proportion of engine-friction to total power came out rather high. On the second and third trial this defect was remedied by placing larger pulleys on the countershaft and running the engine only up to 100 revolutions a minute. At the same time the lubrication of the journals of the countershaft was gradually made more perfect, and a corresponding saving of power was effected. The mechanical friction of the dynamo and the power required to drive the fan for cooling the armature was found by running the dynamo when the field magnets were not excited, and the magnetic friction has been computed as the difference between the power put into the dynamo and its internal electrical energy. This was the only way possible with the plant at disposal, but it is not an accurate method on account of the difficulty of estimating exactly the power lost in such a complicated system of driving gear. Hence the figures in the line headed "Magnetic Friction" are of a somewhat erratic character, and can only be taken as rough approximations. The horse-power required to excite the field magnets is inclusive of the loss in the rheostats by which the potential of the machines was regulated. It will be seen that the proportion of electrical output to indicated power is most favourable where the load is greatest, and had there been a third dynamo and a corresponding increase of current, it is probable that the figure instead of being 66 per cent. would have come out at 70 per cent. Now the loss of potential between the dynamos and the lamps is 5½ volts, the lamps being 110 volts, and we receive thus for every horse-power indicated an electrical energy of 492 watt at the lamps. The lamps require 3·25 watt per candle-power, and thus every indicated horse-power produces 151 candles of actual light.

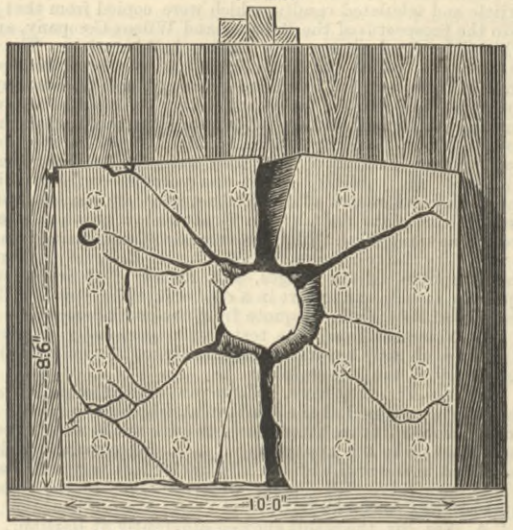
	Victoria trials, October 7th, engine 144—150 revs.											Ditto, Oct. 14th, 98—100 revs.				Ditto, October 17th, engine 95—100 revs				
	Two dynamos.									One dynamo		One dynamo.				Two dynamos.				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	1	2	3	4	5
Engine friction	23·4	23·8	23·8	26·5	25·5	27·5	27·5	26·6	27·5	23·5	23	22·5	22	21·7	20·4	31	30·7	31·2	33·3	15·3
Shafting and belting friction..	21	21	21	21	21	21·5	21·5	21	21	20	20	19·5	19·5	18	17	8·75	8·75	8·75	9	8·5
Mechanical friction of dynamo, fan, &c. ..	4·04	4·0	4	4	4	4	4	4	4	2·1	2·1	2	2	2	2	4	4	4	4	4
Magnetic friction	2·05	1·95	1·8	4·15	·03	4·09	4·2	6·2	7·7	16·06	12·87	4·6	4·2	1·9	2·6	8·8	?	9·8	3·41	1·42
Loss in armature	1·51	1·52	1·55	1·45	1·51	1·51	1·5	1·4	1·4	2·24	2·28	2·4	2·4	2·6	2·4	3·25	3·6	3·95	4·44	·575
Loss in field magnets and resistances	6	6	6	6	6	6	6	6	6	3	3	3	3·1	3·1	3	6	6·6	5	5·75	6
Net electrical output at terminals of dynamo.	45	46	45·5	47·5	49·5	52·6	51	48·8	47·8	31·7	31	34·7	34·7	37·1	34	92	92	92·5	106	10·7
Total indicated horse-power	103	103·2	103·15	110·6	107·8	117·2	115·7	114·4	115·4	98·6	94·25	88·7	87·9	86·4	81·4	153·8	152·5	155·2	165·9	76·5
Percentage of net electrical to gross indicated horse-power ..	44	44·5	44	42·7	46	45	44	42·5	41·6	32	33	38·8	39·5	43	42	60	66·6	59·5	64	53

Returning to our general problem, we have yet to consider the loss of energy in the leads and lamps. As regards incandescent lighting in private establishments, the loss in the main leads must always be very small, for the simple reason that a great difference of potential at various points of the circuit would be fatal to the independence of one lamp from the other. A variation of 2 per cent. in the electro-motive force can already be detected by an experienced observer, and if a greater variation were to be allowed it would be impossible to switch out a group of lamps near the dynamo without at the same time causing the lamps at the far end of the circuit to brighten up considerably. It will therefore be quite safe to assume that in a well-designed private installation the maximum loss must never be more than about 2 per cent. in the main leads. The loss in the branch leads can be taken at about ½ per cent., so that the total loss in the distributing plant will be 2½ per cent.

As regards arc lighting the case is different. The lamps are generally placed at considerable distances apart, and being connected in series, the loss of potential in the leads has no effect on the lamps as long as the dynamo is sufficiently powerful to keep up the proper current. The energy required at each lamp varies with the illuminating power of the lamp, but not in simple proportion. It also depends on the size and quality of the carbon, the length of arc, and the more or less perfect feed of the lamp. To give any kind of rule applicable to all cases is next to impossible, but as a fair average we may take it that a continuous current of fifteen to seventeen ampères will, with good carbons, give a light of 2000 candles measured on an angle of 45 deg. to the horizon, the difference of potential between the carbon points being 45 volts. The shunt coil of such a lamp will require about 0·25 ampère, and the main coil will have a resistance of about 0·1 ohm, so that the total energy which is required for regulation can be taken as 37 watt, corresponding to a loss of 5 per cent. of the total electrical energy supplied to the lamp. The loss in the cable is a most variable quantity, and must be determined specially in each case, but for a rough preliminary estimate it will generally suffice if we allow a loss of about 3 volts per lamp. We can safely reckon that with modern good dynamos, the electrical output varies between 70 per cent. for small machines, and 80 per cent. for large ones. The leads in incandescent lighting absorb 2½ per cent. of the output, or 1·75 per cent. of the mechanical energy if small machines are used, and 2 per cent. if large machines are used, thus bringing the percentage of power actually converted into light down to 68·25 and 78 respectively. Incandescent lamps are now made which have a long life if worked at 3·25 watts per candle, and with such lamps the amount of light received for each horse-power expended will be 154 candles with small dynamos, and 176 with large dynamos. On account of difficulty and danger in using currents of very high electro-motive force, arc light dynamos are generally made of small or moderate size, and their output can be taken at about 70 per cent. It will therefore take 1·58-horse power to produce a light of 2000-candles, which is at the rate of 1260 candles per horse-power applied to the dynamo.

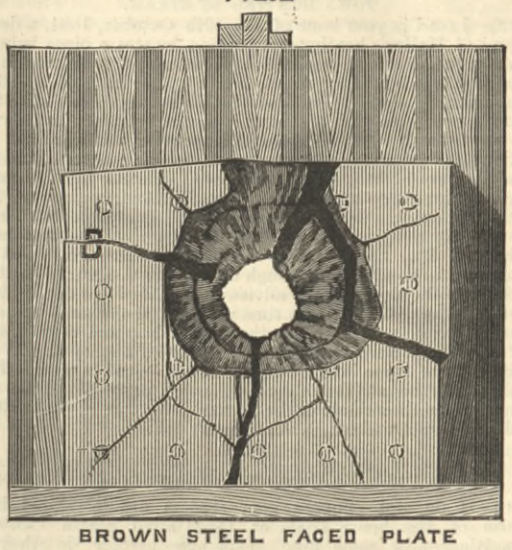
ARMOUR PLATES AT SPEZIA.

FIG. 1.



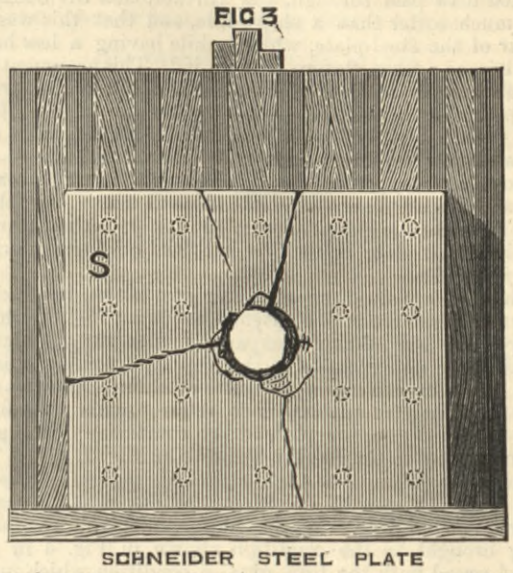
CAMMELL STEEL FACED PLATE
AFTER 1 BLOW FROM 100 TON GUN STEEL PROJECTILE

FIG. 2



BROWN STEEL FACED PLATE
AFTER 1 BLOW FROM 100 TON GUN STEEL PROJECTILE

FIG. 3

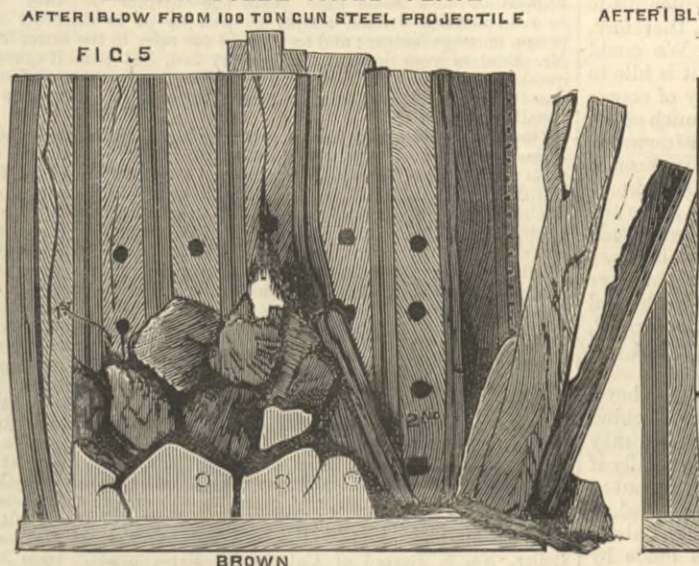


SCHNEIDER STEEL PLATE
AFTER 1 BLOW FROM 100 TON GUN STEEL PROJECTILE

FIG. 4.

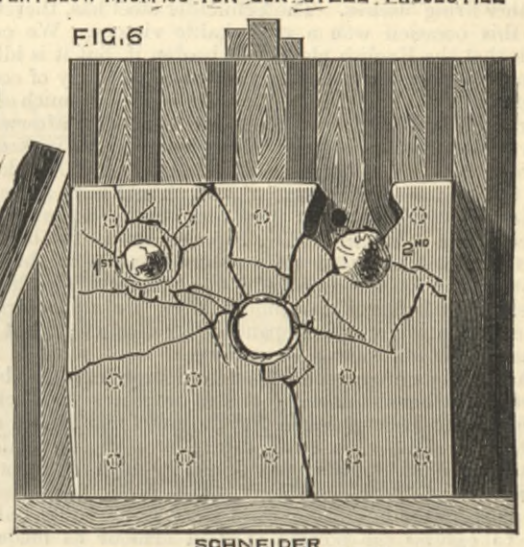
CAMMELL
AFTER 1 ROUND FROM 100 TON GUN
" 2 ROUNDS " 10 IN "

FIG. 5



BROWN
AFTER 1 ROUND FROM 100 TON GUN
" 2 ROUNDS " 10 IN "

FIG. 6.



SCHNEIDER
AFTER 1 ROUND FROM 100 TON GUN
" 2 ROUNDS " 10 IN "

THE CONCLUSION OF THE SPEZIA PLATE TRIALS.

WE have noticed the Spezia competitive plate trials of October last briefly, but gave no figures. We explained that cholera had prevented officers or other foreign visitors being present. We question if permission was given to any visitors who were not officially connected with the trial. We have been wanting to get official photographs. In the absence of these we cannot do better than reproduce a few cuts, evidently taken from photographs, which appeared in the *Annales Industrielles* and others in the *Revue Maritime*, together with a tracing which we obtained of a drawing made on the ground of a recovered projectile. Of course we cannot be responsible for the accuracy of these in the same measure as if they were our own drawings, but the effects are of so sweeping a character that we are satisfied that they are good to all intents and purposes, and they have all the appearance of being carefully and well drawn, and tell their own tale much more clearly than words could do. To recapitulate briefly the story of the trial.

In 1882 a precisely analogous competitive trial took place at Muggiano, close to Spezia—*vide* THE ENGINEER of November 24th and December 1st, 1882. The dimensions of the plates in the two trials were nearly the same. The backing in the case before us is somewhat similar, though decidedly stiffer. The order of the plates is the same, but the tests applied are different. Some of our readers may remember that in 1882 Messrs. Schneider's shield stood the best. We then congratulated them on the wonderful plate they had brought forward. We also, however, expressed a wish to see the trial repeated, because Schneider's plate had the advantage of being much better bolted on to the backing, and there was a question about tempering. The view we took was that which is expressed in the following words when our results were given in a paper read at the R.A. Institution :—"The steel had a fibrous, tough look," and "apart from the question of the bolts," it "stood decidedly better." At the same time, however, a trial took place at Ochta at St. Petersburg, when a Cammell compound Wilson plate held together much better than a steel one of Schneider's tried in comparison. This result had to be weighed against the Spezia trials, but it was on a smaller scale; 12in. is a different matter from 19in. The fracture of a very large iron plate is almost always harsh, and the fibrous look and general behaviour of the steel led us to suggest at the time that it would be wise to try if soft steel could not be employed instead of iron as the foundation plate of compound armour. The combination of greater elongation and greater tenacity, as we pointed out—ENGINEER, January 12th, 1883—ought in the long run to make steel more than a match for iron. In last spring, March 20th, 1884, a compound armour at Copenhagen behaved better than steel—*vide* ENGINEER, March 28th and May 30th; but the plates were only 9in. thick. The fragments of the 19in. compound plates, however, tried at Spezia in 1882, subsequently to the breaking up of the targets, had shown greater hardness than the steel, and subsequently compound plates had behaved very well under the blow of the 100-ton gun, so that the Italian authorities considered that their preference for it was justified. The manufacture of compound plates was to be commenced shortly in Russia, while Marrell has for some time made them on Wilson's patent, and France herself employed compound plates as well as those of steel.

FIG. 9.

ELEVATION OF TARGET AND BACKING

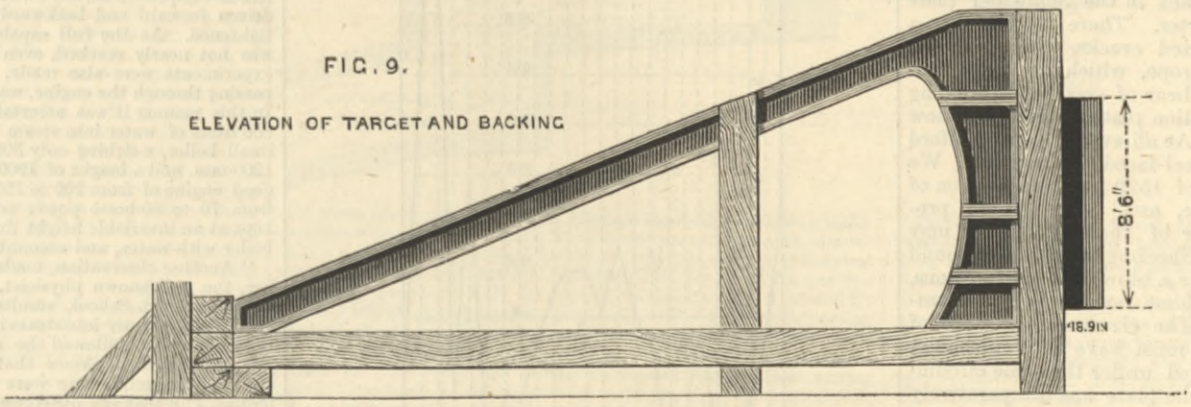
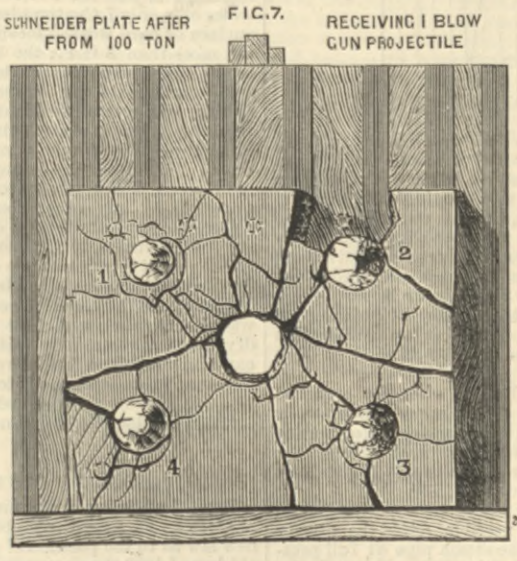


FIG. 7.

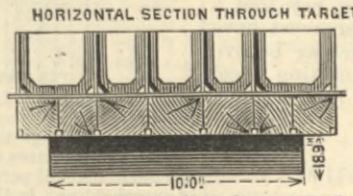
SCHNEIDER PLATE AFTER RECEIVING 1 BLOW FROM 100 TON GUN PROJECTILE



2 & 4 FROM 10" GUNS

FIG. 10

HORIZONTAL SECTION THROUGH TARGET



SKETCH OF 43 C.M (16·9IN) PROJECTILE AFTER PERFORATING THE 48 C.M. (18.9IN) STEEL PLATE SCHNEIDER

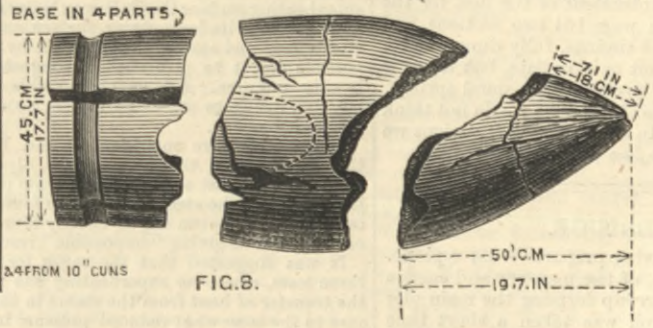


FIG. 8.

Under these conditions the trial at Spezia last October was specially interesting. We are informed that on its result depended the order for the plates for the Lepanto. The programme was as follows:—Cammell and Brown compound and Schneider steel plates 10ft. by 8ft. 6in. by 18·9in. (3050 mm. by 2600 mm. by 480 mm.) were mounted on frame and backing shown in Figs. 9 and 10. One round was to be fired at the centre of each plate from the 100-ton breech-loading Armstrong gun, with a projectile weighing 1841 lb. (835 kg.) with a striking velocity of 1864ft. (568 m.) per second, making a blow of 44,340 foot-tons, or 8337 foot-tons per inch circumference, implying a calculated perforation of 30·27in. of iron, and taking the target's weight as 29 tons, an amount of energy of 1529 foot-tons per ton of plate. As the greatest amount of energy per ton of plate in the previous Spezia trials was 1046 foot-tons, while the calculated perforation through iron was 25·2in., it may be seen that this test was very severe indeed; in fact, the plates were enormously outmatched on any standard of estimation. The effects are shown on the Cammell Brown, and Schneider plates respectively in Figs 1, 2, and 3. These we have discussed on a former occasion. The steel-faced plates obviously suffered much more than the steel one, but there appeared distinct reason to think that they had done more towards stopping the projectile than the Schneider plate, inasmuch as the shot went through the latter in a much more complete condition. We have received a drawing of the fragments taken out of the butt subsequently, which

we give in Fig. 8. It was argued fairly enough that a shot with less velocity might have been stopped altogether by the steel-faced plate, while the steel-plate would have allowed it to pass through, and further, that the backing was much softer than a ship's side, and that this was in favour of the steel-plate, which, while having a less hard face, has, as a mass, "more bone in it." This argument we thought might be fairly held at this stage of the trial. The plates were next subjected to the fire of the 10in. gun, with a striking velocity of about 2000ft., with the following results—on November 5th, 6th, and 7th:—

Brown's plate, penetration first round, 12·6in. (320 mm.), a great part of plate detached; second round, the plate demolished to the extent shown in Fig. 5. About three-fourths of the plate being now stripped off, further firing was impossible.

Schneider's plate then received two blows, producing cracks and fracture to the extent shown in Fig. 6, which is given for the sake of comparison with the steel-faced plates. The shot is stated in the French accounts to have been more broken up against the steel than against the steel-faced English plates. Two more rounds were fired with the 10in. gun, the plate at the conclusion of the programme being in the condition shown in Fig. 7.

Cammell's plate was then attacked, broken pieces of plate being thrown off to an amount estimated at nearly 5 tons—5000 kilogs.—by the first round, and the plate being brought to the condition shown in Fig. 4 in the second round with the 10in. gun—a condition which made further firing useless. The Schneider steel has, therefore, on this occasion won a remarkable victory. We could wish that the English plates had beaten it, but it is idle to ignore the fact that they were beaten. It may of course be argued that the steel-faced plates absorbed so much of the energy of the first heavy blow that they were afterwards in a worse position than the Schneider which let it through more easily. The natural reply is that the makers knew the tests that would be applied, and should have made the plates to stand well under these conditions, and few would sacrifice the power of holding together shown by the steel, for the possibility that the steel-faced plate might have kept out fire, while the steel admitted it in some hypothetical case. The Italian Government have, we are informed, ordered plates for the Lepanto from Schneider, but this statement is, we believe, premature.

As far as we are able to form a conclusion from the above, it would be that on this scale our compound armour is behind Schneiders. It is possible that Cammell and Brown may snatch the victory on some future occasion, especially if better means are found of working very thick plates, but at present we are inclined to think that it is only true wisdom to recognise the liability of steel-faced iron on this scale to fail to exhibit the powers of steel armour as made by Schneider. All the compound armour victories have been with thinner plates. We should by no means say that the compound principle, if carried out with hard and soft steel, may not be the best, but when the results we give occur repeatedly with iron, and with intervals of time sufficiently wide to develope manufacturing operations fairly well, it is idle to shut our eyes to them. Without seeing the targets themselves, there is evidence enough in the drawings to tell something to those who have seen previous results. For example, the crack in the steel below the letter S precisely resembles the long vertical crack in the Schneider plate fired at in 1882 in its character. There may be seen a succession of short, disconnected cracks, looking in the sketch like the twists in a rope, which are very characteristic. We trust we may hear of success before long with steel faces on steel foundation plates, which have now been some time under trial. At all events, we can afford not to be discouraged about steel-faced iron armour. We have spoken here of the blow of 1529 foot-tons per ton of plate being an enormous one, and quite out of proportion to the resisting power of the plate. We may remind our readers that at Shoeburyness a compound Cammell plate on granite bore a blow of 2870 foot-tons, the plate stopping the shot without breaking—*vide* Engineer, September 28th, 1883. The circumstances were, of course, special, but the strain must have been enormous. We have never seen steel tried under the same circumstances, and, as in other cases, the plate was comparatively small, being 12in. thick. We may, however, say that a shield behaving in so remarkable a manner must have elements of great power. We may add that we believe before long Sir W. Armstrong may be making steel armour as well as Sir J. Whitworth.

EXPRESS ENGINE—MIDLAND RAILWAY.

In our impression for February 6th we published as a supplement an engraving of the new express engines designed by Mr. Samuel Johnson, locomotive superintendent of the line, for the Midland Railway. We now give on page 164 two sections, and half a front elevation, of one of these engines, fully dimensioned. It will be seen that the bogie can not only radiate, but traverse laterally. Steadiness is secured by two opposing spiral springs. Our engravings explain themselves so fully that we do not think further description is necessary. In succeeding impressions we shall give further drawings of these fine engines.

THE FORTH BRIDGE.

On page 168 we publish an engraving prepared from a photograph taken on the 25th July, 1884, of the masonry and caisson of the north-eastern column of the group forming the main pier on the Inchgarvie. The photograph was taken a short time before the masonry reached the level at which the bed-plates carrying the steel superstructure will be carried, the forest of holding-down bolts being then not completely built in. The tops of these bolts give an idea of the level of the bed-plates. We have already described the caissons and piers.

Electric Lighting at the South Kensington Museum.—It has been decided to use a set of the Electrical Power Storage Company's accumulators for the maintenance of 100 lamps in the Science and Art Department.

LETTERS TO THE EDITOR.

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

TOWN HEATING BY STEAM.

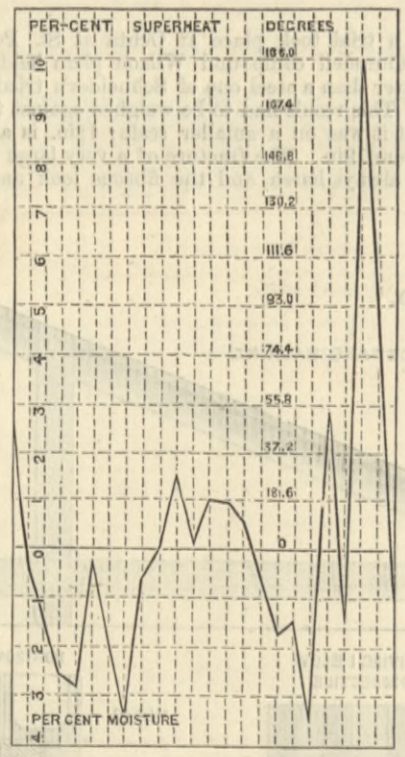
Sir,—I read in your issue of the 10th October, 1884, a detailed account of Holley's heating and cooking by steam pipes being laid under the streets and supplied by boilers at fixed intervals; the paper was read by Mr. G. H. Bartlett, M. Inst. M.E., British Association, Section G. It states that Holley's system was first tried at Stockport in the year 1876, and is now in operation in New York and several other towns, giving the greatest satisfaction. I am heartily glad to hear of this invention proving a success, and at the same time would seek information as to whether this is a genuine American invention or imported from England, because in 1875 I wrote out in rough detail my invention of carrying steam underground and supplying the same to houses, churches, warehouses, workshops, &c., the steam to be supplied from boilers at fixed intervals. I submitted my rough details to Dr. Henry Woodward, of the British Museum, for advice and skilled opinion upon the scheme. The opinion at the time was that the scheme was of too great magnitude. I then let the matter drop and came here; in 1877 or 1878 I first saw an account of Holley's scheme. In detail it differs from mine, and I consider it not equal to mine. If you would kindly insert this in your esteemed paper it will no doubt open up some discussion on the matter. H. Gray.

Alten-road, Auckland, N.Z., January 5th.

BOILER PERFORMANCE AND THE QUALITY OF STEAM.

Sir,—I do not suppose your readers are interested in the results of the boiler trials at the United States Centennial Exposition—now some nine years ago—neither do they care to read articles written simply to puff up or to discredit any person or manufacture; and so I would not refer to the letter from Mr. Buel in your journal for January 3rd, but that it opens a question of much interest and importance to every engineer, namely, what reliance can be placed upon calorimeter tests as usually conducted?

One reason why the figures given by Mr. Buel in this and a former article are "not a full, correct, or fair statement of the facts in the case," as stated by me in a letter published in The Engineer, August 15th last, is because they ignore the very grave doubts there are as to the so-called calorimeter tests. These doubts were well discussed in the technical papers of that time, and a very slight examination of the published report is sufficient to convince any engineer that these tests were subject to such serious errors that any deductions from them other than to say that the steam was dry or wet, as it came within or without the limit of error, is impossible. Where this limit might not reach may be difficult to say. The apparatus used for the tests did not permit of weighing the water condensed from the steam to a nicer degree than ¼ lb., though sometimes a guess was made at the eighths. As the average quantity did not exceed 10 lb., this admits an error of 2½ per cent. The thermometer read to single degrees, and finer readings were estimated. As each degree represented upwards of 400 heat units, this error in reading might have been as great as 3 per cent. That the actual errors were great is shown by calculating any set of the tests, and observing the erratic variations in the results. Below is a graphic representation of the result of such calculations of the "Log. of Economy Test of Galloway Boiler, No. 3, Record of Calorimeter Experiments," page 247. Nine of the observations show superheated steam, one as much as



188·85 deg., though there was not an inch of superheating surface; the remaining sixteen show various degrees of moisture in the steam, some as much as 3½ per cent., and the average of all show a few degrees of superhehting. In the capacity test of this same boiler, wherein it was doing about 30 per cent. more work, the log. shows an average superheat of 11·68 deg. Every engineer must see that without any superheating surface the Galloway boiler must give saturated steam; and that with its large water surface and steam space, under the steady feed and careful firing shown by the logs, it is simply impossible for it to give such a changeable quality of steam each twenty minutes. I have chosen this boiler as an illustration because, owing to its construction, no one will accuse it of such erratic behaviour.

These facts were so evident to Mr. Emery, when he prepared the official report, that he wrote—p. 81—"The experiments at the Exhibition suggest some improvements in the apparatus for testing the quality of the steam." He also found it necessary to omit the calculations of seven out of twenty-four observations, in the case of one boiler as giving "impossible" results—p. 139.

It was suggested that the cause for apparent superheating in these tests, where no superheating was possible, might be due to the transfer of heat from the steam in the steam pipe at full pressure to the somewhat reduced pressure in the ⅜in. perforated pipe within it, through which the steam was taken for the calorimeter. It is, however, demonstrable that this could not possibly amount to a superheating of more than 0·3 deg., or an addition of more than one-sixtieth of 1 per cent. to the thermal value of the steam. But several times this amount would be lost by radiation from the, say, 10ft. of ⅜in. pipe leading to the calorimeter, which, even if covered with felting an inch thick, would lose 260 heat units per hour. Supposing only two minutes were occupied in the experiment, this would amount to over four times the possible superheating suggested. It might be claimed that even if each separate observation was liable to error, the average of a large number would practically eliminate such errors. This by no means necessarily follows, because the "personal equation" would be most likely to carry the error always in one direction with a given set of experiments, as would also a given method of handling the apparatus.

It was with these considerations in view that the editor of the *Manufacturer and Builder*, Dr. P. H. Vanderweide, prepared the article and tabulated results, which were copied from that journal into the prospectus of the Babcock and Wilcox Company, and from which Mr. Buel gives a few figures in his article. The *Manufacturer and Builder* took the ground that as there was a probable error of 3 per cent. in the calorimeter experiments, that any boiler showing by those tests a less variation than 3 per cent. either way was entitled to the credit of "dry" steam, and any over that might justly be called "wet," and as no boiler showed a greater average superheating than the limit of error they were not credited therewith. This table was published about one year before the final issue of the authorised report of the judges, and any one interested will find sufficient data given by Mr. Buel to show how accurate it was from that standpoint. That its standpoint was fair and reasonable is shown by the testimony of Mr. Charles E. Emery, chairman of the committee of the judges, and author of their report, when upon the stand as an expert in a case before the Superior Court of the city of New York. I quote from the court records:—

"Q. You mean to say the tests made personally by yourself at Raritan were more accurate scientifically and technically than the tests made at the Centennial?

"A. Yes, Sir, they were. There was one question in regard to the calorimeter used at the Centennial, which I never could explain until I thought it over after the tests were made, and consequently made changes in the apparatus . . . which would reduce the variations in the result by the calorimeter test very materially.

"Q. Are there still doubts with reference to the calorimeter tests at the Centennial?

"A. Yes, Sir, the result showed differently at Raritan.

"Q. Taking the table from the *Manufacturer and Builder* of November, 1877, is that a fair or a fairer test of the capacity of the boilers than the one in the Centennial [report], assuming it is made as therein stated?

"A. From the light that I have since the Raritan experiment, I should consider that an entirely fair method of presentation."

As Mr. Buel says, this table of Centennial tests has disappeared from the recent editions of the Babcock and Wilcox Company's catalogue, and for the reason that matters of more immediate interest to steam users have taken its place. The fact that of the fourteen boilers tested at the Centennial there are but three which may be fairly said to be now upon the market in this country, and that probably 10-horse power of the Babcock and Wilcox boilers are sold to one of all the others combined, is sufficient reason why that company can afford to drop the subject.

There are other equally strong reasons why the statements originally published by Mr. Buel were not fair—he has himself proved them to be neither full nor correct; but it is not necessary to encroach upon your valuable space further in order to state these at the present time. Geo. H. Babcock.

New York, January 30th.

THE HONIGMANN FIRELESS LOCOMOTIVE ENGINE.

Sir,—In connection with an article on the above subject, which appeared in your issue of January 23rd, I hand you herewith a translation of an interesting statement by Herr M. Honigmann, from the *Zeitschrift des Vereins Deutscher Ingenieure* of February 21st. E.

London, February 11th.

[Translation.]

". . . . Last week I had a visit of an officer of Engineers commissioned by the British War-office, and also of an engineer of Messrs. Beyer, Peacock, and Co., for the purpose of acquiring accurate information with regard to the capability of the caustic soda boiler to produce steam. For this purpose repeated observations were made on the boiler of the Aix-la-Chapelle tramway engine. This boiler has a diameter of 1200 mm., with a total height of 1900 mm., of which the lower portion of 1400 mm. belongs to the soda compartment, into which the 120 heating tubes of the water boiler protrude. The latter has a height of 500 mm.* The total weight of the boiler, inclusive of soda and water, is about 3000 kilogs. The observations were made on a siding of the Aix-la-Chapelle tramway outside the city, the passenger cars being driven forward and backward at a great speed, with their brakes tightened. As the full capability of the boiler to produce steam was not nearly reached, even with the greatest speed, overflow experiments were also made, during which the steam, without passing through the engine, was admitted immediately to the soda. In this manner it was ascertained that the boiler changed about 800 litres of water into steam in forty minutes. Accordingly this small boiler, weighing only 3000 kilogs., and having a diameter of 1200 mm. and a height of 1900 mm., produces as much steam as a good engine of from 100 to 120-horse power, or an inferior one of from 70 to 80-horse power consumes. The steam pressure was kept at an invariable height during this experiment by feeding the boiler with water, and amounted to between 5 and 6 atmospheres.

"Another observation, made in the presence of Professor Wüllner, the well-known physicist, and Rector of the Aix-la-Chapelle Technical High School, resulted even in a capability of changing 1350 litres of water into steam in one hour. It will be interesting to those who have followed the most recent discussions referring to the soda boiler to know that the heating surface on which the observations referred to were made amounted to only 10 square metres, and that the difference of temperature between soda and water was only 7 Centigrades. Now for one square metre heating surface of hard worked locomotive or marine boilers are reckoned not more than 3-H.P.; the soda boiler, however, gives, according to the above statements, steam for from 8-H.P. to 12-H.P. per square metre heating surface. This result, moreover, is not surprising, and was self-evident from the beginning, as it is the particularity of the invention that, for every quantity of used steam, an equal or even larger quantity of steam of high pressure is produced immediately. In any case it shows indisputably that the soda steam boiler is a source of power which cannot even be approached by any other source, whether this be the fired steam boiler, the hot water boiler, or electricity.

"In conclusion, it may here also be remarked that in consequence of the recent erection of the copper evaporating boilers for the Aix-la-Chapelle tramway by Mr. M. F. Gutermuth, assistant at the Technical High School, the consumption of coal in the soda process was investigated, and that it was ascertained that 7·1 kilogs. of dry steam were produced with 1 kilog. of low-priced pit coal. The experiments referred to above will be repeated at any time at the request of those who are interested in them.

(Signed) "Moritz Honigmann.

"Aix-la-Chapelle, February 11th, 1885."

CONTINUITY IN PATENT LAW.

Sir,—In offering some further remarks on the above subject, I propose to consider the probable effect of the change made by the new law as to the position of provisional specifications. Under the old law of 1852 the patent was granted on the provisional specification with the condition of afterwards filing a complete specification in substantial accordance therewith; but under the new law of 1883 the complete specification has to be filed and accepted by the Comptroller before the patent is granted, which, however, when granted, bears date from the filing of the provisional specification. The point, then, to be considered is as to the manner in which the courts are likely to regard any question that may be raised on the provisional specification. Will all such questions be regarded as precluded by the examination of the two documents in the Patent-office, so that only the complete specification will have

* The Engineer, 1885, p. 60.

to be considered by the Court? or will the inquiry be allowed to extend to both specifications as under the old law?

If the patent took its date from the filing of the complete specification, it might be reasonable to accept the examination in the Patent-office as final; but it appears to me that to do so, with the date fixed by that of the original application, may offer a premium to dishonesty by tempting an applicant to insert in his complete specification something that he may have derived from the invention of a subsequent applicant. It is scarcely to be expected that if such a point were raised on behalf of the subsequent applicant, any Court would refuse to consider it; but there might be great difficulty in proving the piracy. But this is not the only question that might arise on a comparison of the two documents. It appears to me reasonable to suppose that a Court would consider any point of a legal, as distinguished from a technical, nature; and would receive evidence on any point that could not possibly have been before the mind of the examiner at the time when he had to satisfy himself of the substantial identity of the two documents.

On the other hand, it is very desirable, in the interest of litigants, that the Courts should accept the work of the examiners as far as possible, and discourage anything like captious or frivolous objections in order to open questions that might be reasonably regarded as already settled. This, of course, applies to matters of description of invention, and of identity between the descriptions in the two documents, rather than to statements of claim or anything bearing upon them.

As a rule, it appears that the functions of the examiners relate to those parts of the specifications which are intended to instruct the public in the methods of working the respective inventions on the expiration of the patent rights, while all questions bearing on construction require to be dealt with by the Court in the same manner as under the old law. If the respective functions of the official examiners and the Court are duly taken into account on each side, the existing system may be found to work harmoniously, but otherwise there will be a considerable amount of friction and dissatisfaction, owing to the want of accordance between the two co-ordinate authorities.

Considering that the official examiners have only received their powers under the new law of 1883, the action of which has not yet had time to become thoroughly tested, it would seem to be especially incumbent on them to avoid trenching on what may properly be regarded as the exclusive functions of the Courts.

WILLIAM SPENCE.

8, Quality-court, Chancery-lane, W.C., February 16th.

ABERGAVENNY SEWAGE BRIDGE.

SIR,—The bridge described in your issue of the 13th is very different from the design and contract drawings. The bridge, as specified and shown on the drawings, had no top or bottom plate to either boom, and in proof of this we enclose the tracing made by our draughtsman from the contract drawings. The result was, as you may imagine, that when the girders came to be erected they would not carry their own weight and buckled in all directions. They were dragged into shape by ropes and jim crows, and top and bottom plates rivetted on *in situ*, the girders being supported in the meantime by a stage in the middle of the river. Again, at the ends of the girders no provision such as you show was made in the contract drawings or specification for gussets. We do not know who was responsible for all this, but some one had to pay for it, and we do not think it ought to pass unnoticed.

February 16th. CONTRACTORS.

LINKS IN THE HISTORY OF THE LOCOMOTIVE.

SIR,—I cannot accept any statement about the Rocket that differs from the explicit assertion of George Stephenson, and must again record the fact, undisputed till now, that the exhaust steam from the cylinders was originally discharged into the air on either side of the foot-plate; that in consequence of a suggestion from Mr. Booth, who stood beside George Stephenson, "I wish that that steam was turned into the chimney," the alteration was made hurriedly, and, as stated by Mr. D. K. Clark, "on the eve of the trials;" that the Rocket was sent back to Newcastle, where the blast "was made a job of," and I am pretty sure that there was an alteration made about the fire-box, which up to that time had been detached from the boiler, connected only by pipes, and this was probably the engine, as altered, shown in Mr. Phipps' drawing. On several occasions I had the privilege, as a pupil, of hearing Mr. Stephenson speak about these earlier events, both in his own house and in other places.

With further reference to your Links—No. XIX., on page 96—I have deferred writing in order to be able to give you more particular information than I can even now; but Messrs. George Stephenson and Co. made two locomotives which went to the United States. I have a memorandum of them, as they had high top round fire-boxes, being the first so made, and expressly ordered to be higher than was designed; and I believe they were ordered by a Mr. Stevens or Steevens. I hope to send you the dates of order and of shipment for an early issue, with the leading dimensions.

Messrs. Jones and Potts occupied the Viaduct Foundry, Newton-le-Willows, at the time when they, as well as Messrs. Nasmyth and Co., of Patricroft, began building locomotives under Mr. Stephenson's patents—about 1844 or 1845. Messrs. Tayleur and Co. and Messrs. Longridge and Co. put some goods engines, from Stephenson's plans, upon the London and Birmingham line in 1846, and Messrs. Jones and Potts some passenger engines in the following year, the latter being of the type of the "A" engine of the gauge experiments. A comparison of the locomotives on that line at the date named is very interesting, as they were from the old four-wheeler, single and coupled, through the lengthened boiler engines, to the large, heavy, four and six-wheeled Bury's, to the more modern goods and long-boiler "four-wheeler in disguise."

February 24th. GRADUATE.

THE IMPROVEMENT OF THE MERSEY.

SIR,—I have laid the following proposal before the chairman and members of the Liverpool Dock and Harbour Board and others interested in navigable streams:—

"My mind having been much occupied on the subject of directing the course of streams from the bed of rivers, I trust the importance of the subject will prove sufficient apology for the liberty I take in submitting to you a plan which I trust may prove serviceable with regard to the difficulties of the Mersey.

"The removal of the Pluckington Bank being necessary, I would propose utilising the flow of the stream and tide for such purpose, and working under the well-known principle that a certain quantity of water has to pass up and down the river each tide, and that whatever part of the bed of the river may become higher, such proportional enlargement or filling up will be compensated for by a corresponding deepening in another portion of the bed of the river. Thus, though the river Mersey can hardly be termed concave opposite the Pluckington Bank, yet this is the form the current takes, and, in striking the shore of which the Monk's Ferry slip is the centre, the level of the water becomes somewhat higher there than at the opposite side, the pressure from which, I believe, produces an under cross-current, helping to still the weak stream over the Pluckington Bank. I propose forming a submerged weir of loose stones or otherwise in the river, say in continuation of the Monk's Ferry slip, commencing at a point allowing about 40ft. below lowest water level, and carried out and sloping down so as to allow of about 50ft. at lowest water level towards the centre of the river. I would use igneous rock or other water-resisting stone, and finish off with smooth pebbles. Pontoons, filled cradles, or their equivalent might be sunk to form the weir. The result would be—the water which formerly flowed where the weir is placed would be displaced and seek compensation elsewhere, viz., at the sides of the river. The Birkenhead shore being rock, there would be little but the Pluckington Bank sand for the stream to work upon and scour away.

"Should the submerged weir not be sufficient to keep the current off the Birkenhead side, I would propose to build up in part the Monk's Ferry slip* above high water mark, and shape the corner to turn the stream at about right angles to the main body of the stream.

"I would propose a somewhat similar weir across the deep channel in the Sloyne, opposite Rock Ferry slip, and I believe a permanent deep channel with auxiliary helps could be formed up the river.

"I consider I have sufficiently well 'thought out' this subject to meet all objections, and, if needed, I am ready to propose other auxiliary means; but I am strongly of opinion that a comparatively small weir would suffice to carry away down to the rock and prevent reforming of any portion of the Pluckington Bank.

"The mud hoppers, now employed in taking out to sea dredgings, after discharging, might be used to go on to the Welsh coast to bring stone to form the weir. An inducement might be given to shipowners to bring suitable material in the shape of ballast, and thus the weir could be formed at small outlay.

"*Bars on the Mersey.*—On the supposition that these obstructions are not caused by deposit from the river, but rather from the action of the sea in forming a second or submerged coast line, a continuation of which is found past Southport, and through which the Mersey has to force its way, one channel after another becoming filled up, the water forcing fresh outlets,† I have an incompleted theory to deal with the difficulty, and for forming one permanent deep water channel out to sea, also for causing the deep water between Egremont and New Brighton to remove as near to entrance of North Docks as desired.

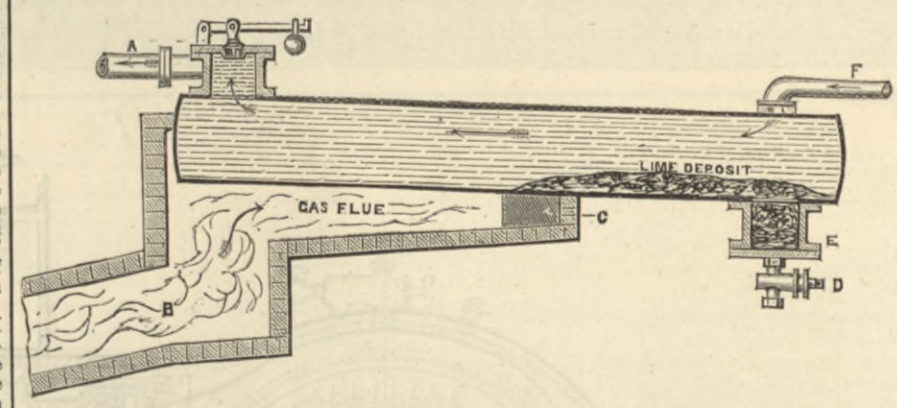
"Should the sand on sea side of bar be found coarser or even as coarse as that on river side, this, I submit, would be very strong evidence of bar not being formed direct by river deposit, as also the probability of the formation at Southport being from sand carried out first into deep water and thrown back by tide and wave, rather than carried direct there. "EDW. FOULGER."

"43, Russian-drive, Liverpool,

"April, 1884."

PURIFYING FEED-WATER.

SIR,—I read, with pleasure in your last issue, your article on "Heating Feed-water," especially that part wherein you describe the action which takes place when water is used containing a large quantity of lime. The nuisance is undoubtedly very great, and the loss and trouble caused by the furring of pipes, pumps, clacks, boilers, &c., can only be realised by those who have had to contend for some years with such a condition of affairs as you describe. Your excellent suggestion of a "setting chamber or tank between the heater and the boiler," reminds me of a plan by which the difficulty was solved some time ago. Some friends of mine had a lot of double-flued boilers with conical cross tubes in the flues, fired by gas from their blast furnaces and supplied with water containing an awful amount of lime. The difficulty of cleaning and chipping double-flued boilers with cross tubes, the defective steaming power when getting scaled, the frequent stoppages, and the cost of repairs, had become almost overwhelming. My friends had tried several nostrums, had heated the water to about 204 deg., and then pumped it into the boilers, but found their pipes, pumps, and clacks choke up and breakages occur. Then they tried heating the water to about 100 deg. and pumping the water into the boilers, which prevented the choking of pipes, pumps, &c., but was dreadful for the boilers. After some serious consultations, and taking into consideration the fact that my friends had a superabundance of gaseous fuel, and



still were often short of steam through the boilers working inefficiently or being under repair, we adopted an arrangement similar to the rough sketch enclosed herewith, which is a plain cylindrical shell heater—in this case 3ft. diameter, 25ft. long—with a gas flue extending about one half the length, so that one end is heated by gas and the other end comparatively cool. The water after passing through the ordinary exhaust heater is pumped into the cool end of the fired heater at about 100 deg. and travels slowly towards the heated end, becoming hot enough to deposit the lime, and having ample time to do so on the journey. On reaching the heated end, it is at boiling point—sometimes above—and is passed out of heater to the boilers. We find that the lime is almost wholly deposited before the water reaches the hottest part of the heater, and is easily taken away—the heater having no internal tubes or other obstruction—at the manhole at the underside at the cool end. The heater being under pressure was fitted with a safety valve on the highest part. This comparatively inexpensive arrangement, I am pleased to know completely solved the difficulty, and now my friends send into their boilers almost pure clean water at boiling point, have plenty of steam, no stoppages, and unimportant cost of boiler repairs. In the sketch, A is the feed pipe to the boilers; B, gas flue; C, flue to chimney; D, sludge cock; E, manhole; F, feed pipe from pump. This affords an illustration of "getting rid of deposit troubles" by taking advantage of local circumstances, but this may be improved if my friends take advantage of the remarks in your timely and valuable article, and put some broken slag in the cool end of heater and collect the lime. I hope that your article will bring relief to many of your readers who are labouring under the disadvantage of having "bad water" for boilers. WILLIAM BROWN.

Stockton-on-Tees, February 24th.

NEWTON'S THIRD LAW.

SIR,—As the leader in your issue of the 13th inst. under the above title has not led to comment, you will perhaps find room for this. The opposition between the two laws is not real—they refer to different things. The second law refers to movement, the third law refers only to stress. In all cases where strain and motion have to be considered together, the motion is sliding—not pulling or pushing—and the slide is at right angles to the strain. Full appreciation of this fact removes all the difficulties of the matter.

Example: A locomotive and its tender are two bodies. They are attached by a tie bar, action and reaction in which are equal. Query: How does the engine move the tender?

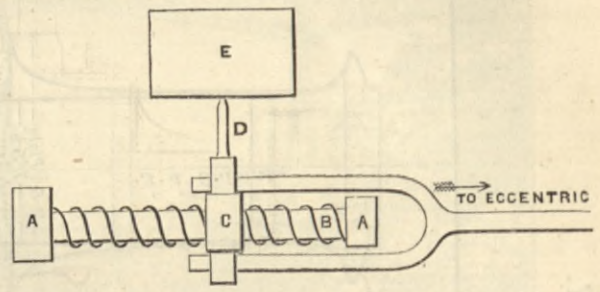
Answer: The engine does not move the tender in relation to itself, but both move in relation to the surface of the earth. The locomotive and the draw-bar and the tender are really one body, and their relative positions remain unchanged. "The action and reaction between them is equal." The only parts that do move are the wheel axles. They slide on the axle-box bushes in a direction at right angles, &c., as before said. This letter is ot exhaustive, but it will put the people you refer to on the ri h track. WM. MUIR.

9, Angel-place, Edmonton, February 25th.

THE FRICTION OF SLIDE VALVES.

SIR,—I am glad you have directed attention to the above subjec, one which, in my opinion, ought to have been discussed by engineers long since. Cut faces and great expenditure of lubricants are only two of many evils due to the resistance of unbalanced slides; and if Mr. Towers would supplement the admirable data already given us by him on the friction of axles by investigating the friction of the slide, he will confer a lasting gift on the profession.

If the area of a supply-port be, say, one-twelfth of that of the piston, and the "box" or interior hollow of the slide covers a supply-port, the centre exhaust port, and the bar dividing them, we may fairly assume the area of this box to be three times that of the port at least, which makes it just one-fourth of the area of the piston. Then, taking the pressure forcing the slide to its face, as determined by the multiplication of this area by the steam pressure and the coefficient of friction resistance to be 0·3, we find the result to be, that as far as we can at present judge, the power required to move the slide is 0·25 by 0·3, or 0·075, or about 7 per cent. of the total power of the engine. Experimental research may show the resistance to be much less, but as to this we engineers are all in the dark.



Might I venture to suggest one mode by which the resistance of a slide while at work could be recorded? Let the valve spindle be fitted with two fixed collars A A in sketch, let two helical springs B B be placed as shown, between these put the eye block C, free to slide on spindle save as regards resistance of springs; the excentric-rod to be joined to this block. On the block put a socket to take a pencil D, which presses against a riband of paper to be gradually drawn off drum E. As resistance of slide varied, so would the play of the eye picee and pencil; then the greater the valve resistance, so also the greater the wave of departure of the pencil line from a datum of no resistance. The springs to be of known strength like indicator springs. The paper could be scale lined for steam pressures and resistances. VOLVOX.

February 24th.

SIR,—I was pleased to see Mr. Wallace's letter in last week's ENGINEER on the above subject, and as it is one which I am much interested in, I venture to explain what appears to me to be the correct method for calculating the actual pressure tending to force the valve against the cylinder face, as follows: The area of the exhaust port in valve, together with the area of the portion or portions of the valve face exposed to or acted upon by the exhaust, multiplied by the pressure in the casing. Of course, according to this rule, the pressure is variable, and may be said to be greatest at the commencement of admission, and becoming gradually less as the valve completes its stroke, at which moment there is, in general, no other surface exposed to the exhaust except the port in the valve. There will be some deductions for back pressure, compression, &c., but I only give what I think is the groundwork of the correct rule.

THOS. H. PERROTT.

Cork, February 23rd.

SIR,—May I suggest that those who have invented or used balanced valves will give the reasons why they have not been continued.

For example, why does not Mr. Webb continue the use of his balanced valves on the London and North-Western Railway? Why did Mr. William Adams abandon the balanced valves on the North London Railway? Why did Messrs. Fowler, of Leeds, cease to use balanced valves on their ploughing engines? Why did the late Mr. Armstrong take the balanced valves out of the Iron Duke and Great Britain broad-gauge locomotives? Why has Mr. William Adams abandoned the Beattie balanced valve in all his new South-Western locomotives? Information on these points would be very valuable.

I understand that one difficulty is that there is no room for balancing in inside cylinders; but it seems to me that Joy's gear gets over this difficulty, and it might greatly improve Mr. Johnson's fine engine recently illustrated in THE ENGINEER if the slides were balanced. VIATOR.

Tring, February 25th.

SIR,—I wish to supplement Mr. Wallace's letter by observing that if it really requires 256-horse power to move the slides in the example he has mentioned, there is another friction involved which is also a serious one, viz., that of the excentrics, usually estimated at 40 per cent., which, added, to 256-horse power, would be 358-horse power, being $\frac{1}{11}$th of the total power of engines.

February 24th. RADIUS.

COAL DISCOVERY.—It is announced officially that Colonel Olascoago, in charge of an exploring expedition in the Andine region—Argentine Republic—has discovered most extensive coal deposits which stretch for hundreds of leagues from the province of San Luis to the Andes and the Neuguen triangle. The samples of coal exhibited are pronounced to be excellent. The Government is so impressed with the information that it has appointed a commission of practical miners, headed by Senor Juan J. Elia, to determine all necessary data.

THE HEALTH EXHIBITION PUBLICATIONS.—A notification from the literary superintendent of the International Health Exhibition, Mr. A. M. Trendell, calls attention to the extensive literature issued in connection with that Exhibition, and which is now about to be published—revised, re-edited, and fully indexed—in a series of volumes. The Exhibition brought together in one place the leading authorities on health and education both of the United Kingdom and abroad. The volumes consist of the reports of conferences, at which various matters relating to the public health were discussed, during the summer of 1884. The hand-books and lectures are equally unique and important, and there are also many miscellaneous papers, which tend to insure the completeness of the whole series. The volumes are to be had by application to Mr. Trendell, Literary Department, Health Exhibition, and are eighteen in number. Each volume contains a number of the hand-books, which were so well received during the Exhibition, or a number of the lectures, or reports of conferences and papers read, and all are provided with a copious index. They have all been written and edited by the most competent authorities, and contain a mass of information not collected in any other form.

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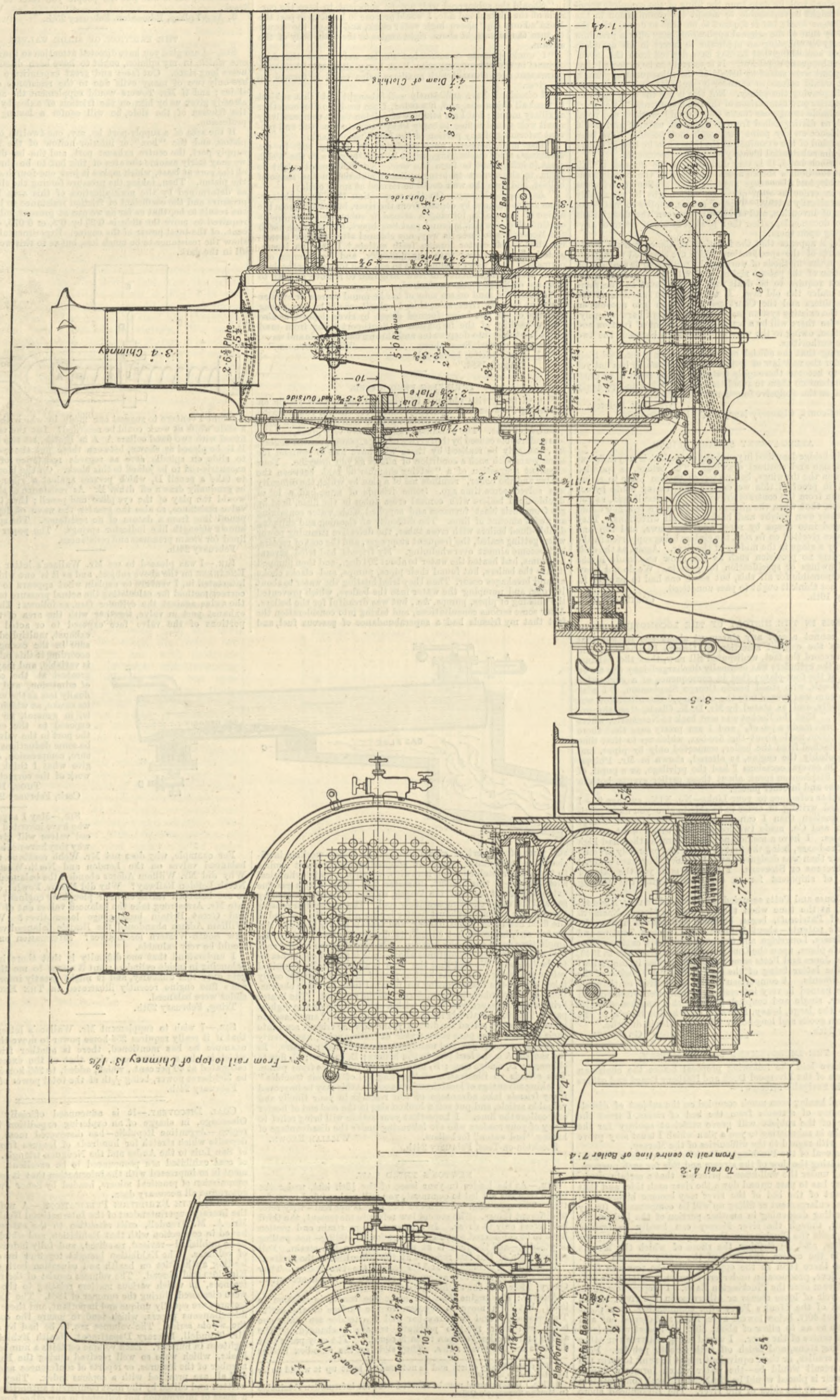
* This slip already exists and is not used—if built up it would be far less dangerous.—E. F.

† This, I believe, could now be effected with the information obtainable in Marine Surveyor's Office.

EXPRESS LOCOMOTIVE, MIDLAND RAILWAY.

MR. SAMUEL JOHNSON, M. INST. C.E., DERBY, ENGINEER.

(For description see page 162.)



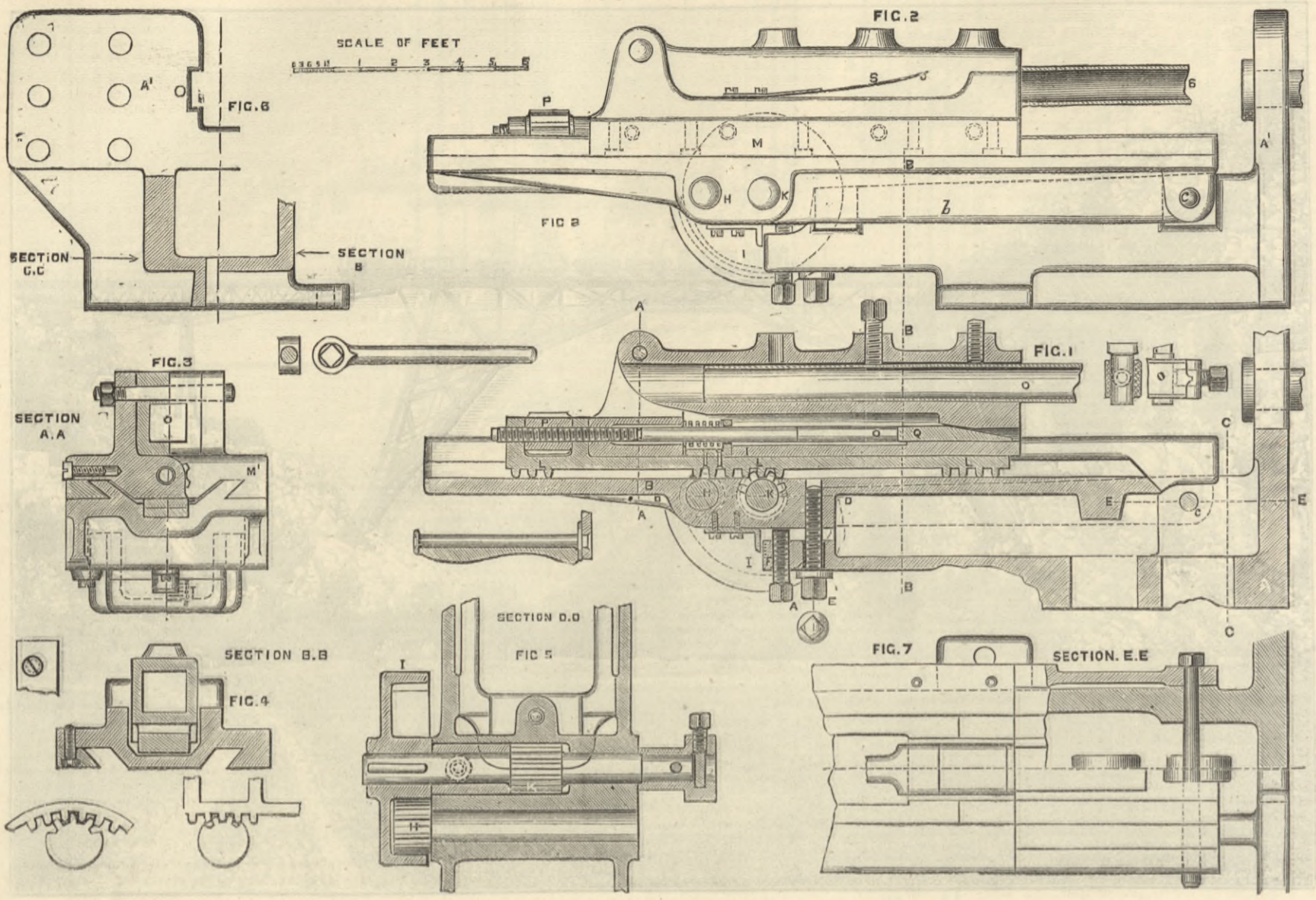
BRIDGE OVER THE BLAAUW KRANTZ RAVINE.

MR. MAX AM ENDE, WESTMINSTER, ENGINEER.

For description see page 162.)

PORTABLE SLOTTING AND KEYWAY CUTTING MACHINE.

MESSRS. J. SPENCER AND CO., ENGINEERS, KEIGHLEY.

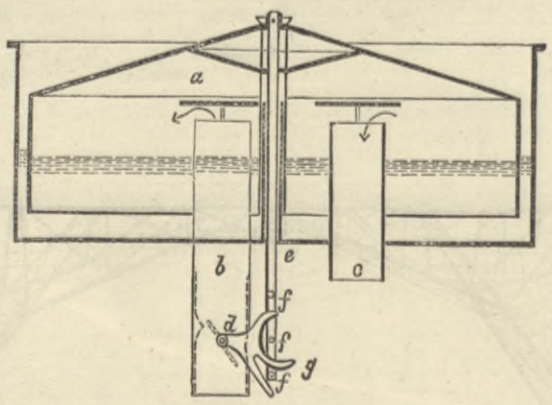


The illustrations above show an ingenious portable slotting or keyway cutting machine made by Messrs. John Spencer and Co., engineers' tool-makers, Keighley, who are the sole makers and owners of the patent right for the United Kingdom. This machine has an arrangement by which the slot can be cut either perfectly parallel or can be cut deeper at the front end or at the back end as may be required. This movement is regulated by the two screws A and E shown in the sectional view, Fig. 1; by means of these screws the slide M, Fig. 2, which carries the cutting tool can be adjusted as required, and set either perfectly square with the angle plate A^1 on the end of the machine—to which the wheel or pulley to be cut is fastened—or it can be set at an angle to the said plate sufficient to give the slot the required taper. On the end of the machine there is an index F, Fig. 1, showing at a glance whether the machine be set for parallel slots or for taper slots, and if the latter, at which end of the hole the slot will be deepest. The sectional view also shows another new and very effective method of relieving the cutting edge of the tool when on the return stroke from the rub or friction which proves so injurious to tools used in the ordinary slotting machine. This movement is made by the handle forcing back the steel wedge Q, shown as supporting the toolholder O, the movement of this steel wedge being slightly in advance of the slide M which carries the toolholder O, allows the tool to drop about $\frac{1}{64}$ of an inch in the return stroke, and when the handle is turned the proper way for cutting, the steel wedge immediately forces the toolholder O up to its proper position and holds it there until the reverse movement is commenced, when it at once allows the tool to drop again. By this arrangement the wear of the tool is reduced, and the cutting edge preserved, which is favourable to the performing of good work with a minimum power, as without the rub or friction the tool can be made keener and to cut easier than would otherwise be possible. The feed is given to the cut by means of the nut P on back end of wedge Q. The internal wheel I is malleable iron, and is driven by a shaft and pinion H. The steel shaft and pinion K, also wheel I, are used for hand power only, and are removed when the machine is driven by steam power. Another part of the invention which is worthy of notice is the method by which the machine is secured to the boss of the wheel or pulley in which the keyway or slot is required to be cut. For articles with small holes a steel mandrel is used, having a groove up the centre to allow the cutting tool to move through the wheel or pulley to be slotted. On the outer end is a winged nut, by which the wheel is fastened on mandrel. The advantage of this arrangement is that the mandrel itself being fixed to the machine in its proper position, all the articles to be slotted are of necessity set true and in their proper positions as soon as placed on the mandrel and secured by the winged nut. According to the breadth of the small wheels to be slotted, either one, two, three, or more can be placed on this mandrel without any care in setting, or any regard to their various diameters or shapes beyond the bosses, the only point of importance being that the various holes shall be nearly the same diameters. The forked contrivance and shell packing block shown—both malleable iron—are used when articles with large holes are to be slotted; and the apparatus passing through the hole, a single screw is sufficient to secure the machine and article to be slotted to each other, which is done both expeditiously and effectively, and without any regard being required either to the diameter or shape of article beyond the boss itself. These machines are made in two sizes, portable and for hand power, the length of strokes being 8in. and 12in. respectively; they and also larger sizes are made for steam power, and yet so that in fifteen minutes the machine can be converted into a portable machine for hand power, and suitable for outside work.

SCHRABETZ'S ANTI-FLUCTUATOR FOR GAS ENGINES.

The accompanying engraving represents an apparatus for counteracting the influence of gas engines upon the pressure in the gas pipes, which manifests itself in palpitation of the flames fed from the pipes, without application of india-rubber bellows.

The apparatus consists of a light gasholder *a*, with vertical sides, floating in water. The gas coming from the main pipe enters under the holder through the pipe *b*, and passes to the gas engine through the pipe *c*. The holder is weighted in such a manner that the gas in it is under a lower pressure than the lowest pressure in the feed main. When the engine draws gas by the pipe *c*, the holder sinks rapidly for some millimetres;



but as the sides of the holder are thin, a very small resistance is to be overcome, so that in regard to the great projection of the holder, this movement takes place without any perceptible variation of the gas pressure in the holder. The conditions under which the gas enters the holder are the same as with the exit, so that the palpitations of the flames fed by the pipe *b* or the connecting main pipe are prevented even in using very sensible Argand burners. The holder *a* sinks rapidly at each filling of the working cylinder of the engine, and rises slowly until the next filling is taken from the holder. But as the speed of the gas engine is governed either in varying the quantity of gas in the charge of the cylinder or in making one or more charges without any admixture of gas, also the pressure of gas in the main pipe is always changing, the amount of gas remaining unconsumed could gradually accumulate and lift the holder. When the holder is stopped in its highest position there would be no more room for spared gas, the pressure in the holder would increase, and at each suction the pressure would change and the flames must necessarily flicker. To prevent this the supply of gas is regulated by a throttle valve *d*, which is actuated by the holder through the rod *e* provided with three stops *f* and the cam *g*. It is made by Mr. Emil Schrabetz, Deutchmeisterplatz, Stadt, Vienna.

The s.s. St. Andre was taken on her trial trip off the mouth of the Tees on the 18th inst. The vessel is the first turned out by Messrs. Craig, Taylor, and Co., of Stockton-on-Tees. She is fitted with a spar deck, and is for French owners. The dimensions are 170ft. by 24ft. by 18ft. 6in., with engines of 60 nominal horse-power, having cylinders 20in. and 39in. by 27in.; working pressure 90 lb., constructed by Westgarth, English, and Co., Middlesbro'.

Enterprise in Palestine.—Mr. Consul Merrill, of Jerusalem, reporting to the American Government, mentions that an attempt has recently been made to build a bridge over the Jordan opposite Jericho, but the bridge is not completed and is not likely to be. He wishes, however, to call attention to the fact that a large part of the timber for this bridge was brought to Jaffa from Europe and transported to the Jordan by means of camels. He is of opinion in regard to timber that a large trade could be created at once by importing ready made windows and doors, and even suggests that much might be done in time by importing houses already framed. Such houses would never displace entirely the stone houses of the country, but for many purposes they would be of great service, and hence would be in demand. He further mentions that most of the new houses which are built have tile roofs. These tiles are imported from France, but in Palestine there are extensive beds of the finest clay, and if a company were formed to manufacture these tiles upon the ground, a considerable business, according to Mr. Merrill, could be built up, since they are coming more and more into general use.

Nine Months' Railway Fatalities.—Altogether the number of persons killed and injured on railways in the United Kingdom in the course of public traffic, during the nine months ending 30th September, 1884, as reported to the Board of Trade, was as follows:

	Killed.	Injured.
Passengers:		
From accidents to trains, rolling stock, permanent way, &c.	31	556
By accidents from other causes	77	467
Servants of companies or contractors:		
From accidents to trains, rolling stock, permanent way, &c.	21	83
By accidents from other causes	374	1660
Persons passing over railways at level crossings	44	23
Trespassers (including suicides)	254	136
Other persons not coming in above classification	28	59
Total	829	2984

Note: In addition to the above, the railway companies have reported to the Board of Trade, in pursuance of the 6th Section of the Regulation of Railways Act, 1871, the following accidents which occurred upon their premises, but in which the movement of vehicles used exclusively upon railways was not concerned, namely, 2 passengers killed and 83 injured whilst ascending or descending steps at stations; 30 injured by being struck by barrows, falling over packages, &c., on station platforms; 2 killed and 19 injured by falling off platforms; and 43 injured from other causes. Of servants of companies or contractors 1 was killed and 680 were injured whilst loading, unloading, or sheeting wagons; 170 were injured whilst moving or carrying goods in warehouses, &c.; 3 were killed and 129 injured whilst working at cranes or capstans; 3 were killed and 241 injured by the falling of wagon doors, lamps, bales of goods, &c.; 3 were killed and 352 injured by falling off, or when getting on or off, stationary engines or vehicles; 4 were killed and 155 injured by falling off platforms, ladders, scaffolds, &c.; 159 were injured by stumbling whilst walking on the line or platforms; 145 were injured whilst attending to stationary engines in sheds; 1 was killed and 34 were injured by being trampled on or kicked by horses; 5 were killed and 422 injured whilst working on the line or in sidings; and 2 were killed and 123 injured from various other causes. Four persons who were transacting business on the companies' premises were also killed, and 63 were injured, making a total in this class of accidents of 30 persons killed and 2848 injured. Thus the total number of personal accident reported to the Board of Trade by the several railway companies during the nine months amount to 859 persons killed and 5832 injured.

RAILWAY MATTERS.

ON the 21st of December last the first railway in Cochin China was opened from Saigon to Mytho, the journey taking about four hours.

IN the report of the directors of the Waterford and Limerick Railway for past half-year, read to-day, the cost of maintenance of way and works is given as £7263 8s. 11d., the locomotive power £11,894 16s. 11d., repairs and renewals of carriages and wagons £3435 2s. 8d. Traffic expenses, £16,424 5s. 1d.; general charges, £2893 3s. 8d.; total mileage, 271m. 7f. 8c.; and total train mileage 352,175 miles, passengers and mixed, and 82,244 miles, goods and cattle and minerals.

TO communicate telegraphically with a moving train, often suggested and attempted, has, it would appear, been successfully accomplished at last. The American *Electrical World* says a test last week, on one of the railroads running out of this city, of the system of Mr. Lucius J. Phelps showed the invention capable of maintaining communication between train and station without difficulty. The apparatus employed operates on the inductive principle, and is said to be simple in detail.

THE following is an extract from a letter written to the *Railroad Gazette* from Lulea, Sweden:—"I have charge of the locomotives on the North of Europe Railroad here, a new line in 65° 30′ latitude, or some 1260 miles further north than any line in Canada, and some 300 miles nearer the North Pole than any line in Russia. The winter has just set in here, and it has come a week too soon, as my round-house—a sort of log cabin made of ties—will not be completed for a week or so. I have to keep a fire in there to keep the boilers and tanks from freezing."

THE Birmingham Central Tramways Company has now opened its depôt in Kyotts Lake Road, and a sufficient number of engines and cars has been obtained to enable them to put on six per day. Unfortunately however, the Public Works Committee have restricted the use of steam below Bradford-street. Meanwhile the extension of the lines in the district is extending. The Oldbury Local Board have given permission for the construction of a line through their township to Blackheath and Rowley; and the Smethwick Local Board have granted a similar concession for the construction of lines in their neighbourhood.

THE American Consul, Mr. Conroy, at San Juan, Porto Rico, states in a recent report that the only railway in that island run by locomotives is in his district, and is the property of a private gentleman, being without any Government subventions whatever. It begins at San Juan and runs to Rio Piedras, a small summer resort, eight miles distant. It is well patronised, and is paying so well that it is to be extended some twelve miles to the town of Carolina. The owner has had great difficulties put in his way by the Government engineers, and only by visiting Madrid was he enabled to obtain permission to build two iron bridges, and to carry out thus far his railway undertaking. The locomotives, rails, cars, &c., are of American manufacture.

AN instrument for measuring the wear of rails is described in the "Proceedings of the Institution of Civil Engineers." The principle on which the construction is based is that the ends of a straight line, moving in the direction of, and equal in length to, the straight line joining the centres of two circles of equal radius, one of which rotates about the other, describe like figures. In using the instrument, one end of an arm is carried round the rail whose wear is to be measured, the other end tracing the exact section on a zinc plate fitted to the instrument; if the section of a perfect rail be now traced on the plate, so as to coincide as far as possible with that of the worn rail, the amount of wear becomes immediately apparent, and the area of the section can be ascertained by means of a planimeter.

THE Alexandria (Va.) *Gazette* of Jan. 7th says:—"A very remarkable accident occurred to an engine on the Virginia Midland Railroad on Monday night, but fortunately no one was hurt. When a passenger train bound north was near Midland station a connecting-rod of the engine broke, completely demolished the cab, knocking it back toward the tender, and catching the engineer and fireman under it. The engine being under no control, rushed on at a rapid speed for some time, with no prospect of stopping, when the engineer succeeded in crawling under the *débris* of the cab and cut the rubber hose of the air brakes, bringing the train to a standstill with no further damage. After the train had stopped the driving wheels of the engine revolved so rapidly as to wear out the rails on the spot where the engine was standing. The train reached this city a little behind time without further accident."

SPEAKING of the two Fontaine engines constructed a few years ago, the Toledo (O.) *Commercial Telegram* of January 12th says:—"One of the engines with a freight train attached made 15 miles in 10 minutes, or 90 miles an hour, on the old Canada Southern track, between this city and Monroe, Mich. The two engines were constructed at a cost of 45,000 dols., including the expense of the tests. They were tried on several roads only to demonstrate the mechanical axiom that what is gained in speed is lost in power. A greater speed than 60 miles an hour is not considered an advantage, and the saving in fuel promised in this engine was not proved. The engines were tried on the Harlem river, the Canada Southern and the Oxford and Port Austin railroads, and Saturday the closing scene in their history occurred by their sale for 2700 dols. to the Lake Erie and Western Railroad. This road will place them in the shop, where they will be reduced to the ordinary style of locomotive, and the Fontaine engine will only live in memory."

FROM a recently prepared statement it appears that the average coal consumption per day for car service on the Brooklyn Bridge is 6 tons, which does the work of moving the 1½in. cable, 11,450ft. long and weighing 40,075 lb., at a speed of ten miles per hour for twenty hours per day, and keeps from ten to twenty cars, weighing 10 tons each, constantly moving, the total number of car round trips per day being 1200. The power required to move the cable and machinery alone, without cars, is 35-horse power, which corresponds to a tensile strain of 1312 lb., or about 66 lb. per ton weight of cable. The *Railroad Gazette* says: Allowing the rolling friction of the cars to be 6 lb. per ton and nothing to be lost by grade resistance—since the cars remain attached to the cable in descending and give up the power lost in ascending—the average power required to keep the cars in motion is 14·52-horse power additional, or a total of 49·52-horse power, from which it results that the coal consumption per horse-power per hour is only 1·36 lb., which is certainly very low, calculated to raise a suspicion that the rolling friction of the cars is not quite so high as assumed, especially as no allowance has been made for the heavy average load of passengers.

THE half-yearly report of the London, Chatham, and Dover Company gives the total cost of maintenance of way and works as £41,992. This included £12,816 for renewal of way. The miles maintained were 154 miles 55½ chains double line, 11 miles 42½ chains single line, and consisted of 12 chains of six lines, 76½ chains of five lines, 4 miles 32 chains of four lines, 1 mile 8 chains of three lines, 141 miles 32 chains of two lines, and 11 miles 42½ chains of one line. The repairs and renewal of carriages and wagons cost £21,495 17s. 9d.; traffic expenses were £98,263 5s. 7d.; locomotive power cost £76,970 3s. 4d.; and general charges, £16,218 14s. The mileage of the company is now—Lines owned by company, authorised, 203 miles 15 chains; constructed, 179 miles 2½ chains; constructing or to be constructed, 24 miles 12½ chains; worked by engines, 176 miles 79 chains. Lines partly owned by company, authorised, 8 miles 43½ chains; constructed, 8 miles 43½ chains; worked by engines, 8 miles 43½ chains. Foreign lines worked over, 6 miles 43 chains. The statement of train mileage gives—Passenger trains, miles run by London, Chatham, and Dover trains, 1,605,551; miles run by trains of other companies, 59,430; total, 1,664,981; goods and mineral trains, miles run by London, Chatham, and Dover trains, 290,040; miles run by trains of other companies, 87,485; total, 377,525, or a total of 2,042,506 miles.

NOTES AND MEMORANDA.

ALUMINIUM is being sold in thin leaves like gold-leaf, and is used for Leyden jars instead of tinfoil. Its use is of course not confined to this, and it is not expensive.

AT the Royal Observatory, Greenwich, the mean reading of the barometer last week was 29·46in. The mean temperature was 40 deg., and 0·9 deg. above the average in the corresponding week of twenty years.

THE deaths registered during the week ending February 21st in 28 great towns of England and Wales corresponded to an annual rate of 20·5 per 1000 of their aggregate population, which is estimated at 8,906,446 persons in the middle of this year. The six healthiest places were Brighton, Birkenhead, Wolverhampton, Bradford, Plymouth, and Hull.

AT a recent meeting of the Paris Academy of Sciences a note on "The Solar Parallax deduced from the Daguerrotype Plates taken by the French Commission for the Transit of Venus in 1874," was read by M. Obrecht. It included a new method of calculation, comprising nearly all the observations recorded. The parallax of the sun as determined on these data is expressed by the formula—$\pi = 8''8\text{in.} - 0''004\ \delta\ L$, where $\delta\ L$ is the correction in seconds of the time for the longitude adopted for the station at Pekin, L = 7 h. 36 min. 30 sec.

THE disincrustation of boilers by means of electricity is again occupying attention in France, and MM. Jeannolle et Cie. having recently described before the tulle manufacturers of Saint-Pierre-les-Calais some very satisfactory results, by passing a current through a boiler and causing, it is stated, the deposition of the carbonate of lime, chlorides of sodium and magnesium, alumina, silica and peroxide of iron, disengaging oxygen and carbonic acid, destroying the adherence of the incrustation, and causing the materials to settle in a soft pulverulent state at the bottom of the boiler.

IN London last week 2526 births and 1497 deaths were registered. The annual death-rate per 1000 from all causes, which had been 24·1, 20·3, and 19·5 in the three preceding weeks, further declined last week to 19·1, and was lower than in any previous week of this year. During the first seven weeks of the current quarter the death-rate averaged 22·1 per 1000, against 24·6, the mean of the rates in the corresponding periods of the five years 1880-4. In Greater London last week 3275 births and 1850 deaths were registered, equal to annual rates of 32·9 and 18·6 per 1000 of the population.

A FRENCH authority gives the following recipe for transparent cement. The advantage claimed is absence of the slighest yellow tinge, so that the addition of the cement is imperceptible, while it possesses an extreme degree of tenacity:—Mix in a well-stoppered bottle 10 drachms of chloroform with 12½ drachms of non-vulcanised caoutchouc in small pieces. The solution is easily effected, and, when finished, add 2½ drachms of mastic, and let the whole macerate from eight to ten days, shaking the mixture from time to time, but without heat. A perfectly white and very adhesive cement is thus produced.

THE obelisk erected in Washington, as a monument to General Washington, was unveiled with imposing ceremonies on Saturday last. The venerable Robert C. Winthrop, of Boston, laid the corner stone of the obelisk on July 4th, 1848, but owing to the bad weather he was not present on Saturday, and the address he had written was read by a member of Congress. The obelisk has been thirty-six years building. It is the highest monument in the world, 555ft. high, and 55ft. square at the base. It contains 82,000 tons of grey granite. The cost has been 1,187,000 dols. It stands on the spot approved by Washington himself in 1791, and can be seen anywhere within a radius of twenty miles. Inside is an iron staircase leading to the summit, and also a steam lift.

A MINERAL hydrocarbon recently discovered near Seefeld, in the Tyrol, occurs crudely in the form of a bituminous rock of peculiar construction; and the bitumen is believed to be composed of the decomposed remains of marine animals. Treated with strong sulphuric acid, the bitumen yields a soft substance, which when neutralised is not unlike vaseline in consistence, but resembles coal tar in colour. It differs from all known vegetable and mineral tars, however, by its odour, and by the possession of peculiar physical properties. It forms an emulsion with water and is partly soluble in alcohol and ether. A mixture of these two liquids completely dissolves it. It is miscible in all proportions with vaseline and oils. The name "ichtyol" has been given to the substance, which is characterised above all by its richness in sulphur, of which it contains about 10 per cent. The *Scientific American* says this element is so intimately mixed with the ichtyol that it can only be separated by the complete decomposition of the latter. Besides sulphur, ichtyol contains oxygen, carbon, hydrogen, and traces of phosphorus. In consequence of the high proportion of sulphur, the new hydrocarbon is regarded hopefully as a medicament or unguent.

IT is stated that the shipments from the port of Pensacola during 1884 showed a slight increase over the previous year's business. There cleared during that time 554 vessels, with a tonnage aggregating 319,633 tons, a gain, as compared with 1883, of 20 vessels and 11,894 tons. There were shipped in excess of 1882-3 8725 loads of sawn timber and 8942 superficial feet of lumber, while the shipments of hewn timber showed a decrease of 1929 loads. Of the total vessels 188 were bound for Great Britain, the aggregate tonnage being 142,552 tons, or nearly one half of the whole. The value of the lumber and timber is estimated at 2,500,000 dols. In addition to this export there were shipped 13,501 bales of cotton against 2300 in 1883. Pensacola has handled cotton for only three or four years, but expects to double this year the quantity of last season. The value of this shipment was upwards of 500,000 dols. so that the export of these two articles was worth more than 3,000,000 dols. The Liverpool *Journal of Commerce* says the shipment of Alabama pig iron from the port of Pensacola to ports north of Hatteras forms a novel feature of her export trade. Several cargoes have been already so moved, and others are arranged for. This pig iron is destined to Philadelphia, Fall River, Boston, and Providence.

PROFESSOR F. E. NIPHER finds from data taken from Dr. Engelmann's observations at St. Louis, Mo., lasting over a period of forty-seven years, that the duration of maximum rains is inversely proportional to the violence, or that the product of violence into duration is constant. This constant is the amount of water which may fall in a continuous rain, and is, for Dr. Engelmann's series of about half a century, about 5in. A rain of 5in. per hour may last one hour. A rain of 4in. per hour may last an hour and a-quarter; and such a rain Dr. Engelmann observed. A rain of 2½in. per hour may last two hours, and several such rains were observed. A rain of 1in. per hour may last five hours. Each of these rains would be a 5in. rain. For a longer period of time than fifty years it is likely that greater rains than 5in. may be observed. The same is to be said if observations are to be taken over a wider area of country. In fact, a rain of 6in. in three hours occurred near Cuba, Mo., some years since. This would increase the value of the constant from five to six, but otherwise the relation will probably remain unchanged. The importance of this law is very great in engineering, where the capacity of sewers, culverts, and bridges must be such as to carry the water. A more general investigation which, *Science* says, Professor Nipher is now making, will determine the duration between the violence, duration, and frequency not only of maximum but of all rains. This work, when completed, will enable an engineer to construct the waterways of bridges of such a capacity that they will probably stand a definite number of years before they are washed away. This number of years will be so determined that the interest on the invested capital during the probable life of the bridge will equal the possible damage when the destructive flood comes which the engineer determines shall destroy his work. The running expense of maintaining the bridge is then the least possible.

MISCELLANEA.

THE *English Illustrated Magazine* for March contains, amongst other well-illustrated articles, one on the art of casting in bronze.

IT is proposed that the South-Eastern British Electric Light Company shall be wound up. Some of the directors seem to object to this.

AN almanack, with a note of engineering interest to each day, has been published by Messrs. Pfeil and Co., of John-street, Clerkenwell.

A QUICK drying black vanish for protecting bright work during transit or in store is made by Mr. W. Wells, of Leith. It is applied with a brush, and when required, is easily removed by means of waste and naphtha.

ON Saturday a new bridge over the lake in the Regent's Park was opened, giving public access between two strips of land, which, with other portions, makes a total of twenty acres of hitherto enclosed land added to the open park.

MR. F. R. STORIE, late engineer-in-chief of the Imperial Dockyard, Nagasaki, Japan, has received from the Mikado the fourth class "Order of the Rising Sun" as a recognition of the valuable service he rendered to the Japanese Government during his long tenure of office.

MR. B. HINGLEY presided at the annual meeting yesterday—Thursday—in Birmingham of the Wages Board. The report stated that employers receipts had advanced £80, and those of operatives £17, making a balance in hand of £148. The chairman remarked that the employers had shown a strong spirit of conciliation in keeping up wages, but he was afraid they could not maintain it. The report was adopted.

AT the annual meeting of the North Staffordshire Mining Institute held on Monday, the report stated that the number of members had decreased by ten, the total now being 244. Mr. F. Wragge was appointed president vice Mr. J. Lucas, and papers were read by Mr. A. Sawyer on "The Temperature and Moisture of Air Currents in Mines," and Mr. F. M. Still on "The use of Lime Cartridges in the North and South Staffordshire Coal-fields."

AMONGST other extensive contracts for constructive work for the Soudan, we notice that Messrs. Clark, Bunnett, and Co. have received instructions from the War-office to erect and ship in fourteen days thirteen corrugated iron buildings for stores, covering an area of about 25,000ft. super. Numerous other contracts are mentioned by our Birmingham correspondent, and Messrs. W. Rose and Co. have orders for their Phœnix hose for the water supply works.

THE Main is to be made into a canal, with a uniform depth of 2·50 metres—8ft. 3in.—by means of weirs and locks. The nature of the river and its banks makes it peculiarly suitable for this treatment. In the plan which is now being carried out, there are five weirs at Frankfort, Höchst, Okriftel, Raunheim, and Kostheim. At each of these places there is on the left bank of the river a side canal with a lock for ships, and on the right bank a channel for rafts.

IT is said that the Government are making use of the Japanese Village, Albert-gate, for the manufacture of a sunshade for our soldiers in the Soudan. Bamboo arches are fixed on each shoulder. From these arches springs a stick which holds an awning of paper on bamboo about 24in. by 18in. and a few inches above the soldiers. If the Japanese make these at the rate they were making some things when we visited the village, they will get at least two finished by the time the Soudan business is finished.

AT the monthly meeting of the Meteorological Society, on the 18th instant, at the Institution of Civil Engineers, a paper was read entitled, "How to Detect the Anomalies in the Annual Range of Temperature," by Dr. B. Ballot, Hon. Mem. Royal Met. Soc. The author shows that it is most likely that only a long continued series of observations can give some evidence of an interruption of rise and fall, especially in latitudes where the temperature of the same day in different years may differ by 20 deg. Cent., as in St. Petersburg.

THE offer of the Government of New South Wales to take 150,000 tons of steel rails in ten years has stimulated invention in the Colony, and the *Colonies and India* says, according to the reports, a Mr. Harrison has succeeded in discovering a method of working the colonial ores at a cheaper rate. "He forces hydrogen through the furnace, and carries off the impurities in a gaseous condition, producing pig iron at something less than £3 a ton, while English pig costs in Sydney at least £4 4s. Experiments on a large scale are about to be made."

MESSRS. ANDERSON AND BARR, the contractors for sinking the pneumatic tubes at the Chestnut-street bridge in Philadelphia, have closed a contract with the Government for sinking the foundation cylinder for the Fourteen-foot Bank Lighthouse in Delaware Bay, by the pneumatic process. The cylinder is to be 35ft. in diameter and 70ft. high, resting on a wooden caisson at the base. The cylinder will stand 17ft. above the water, which latter is 20ft. deep, so that the penetration into the ground is to be 33ft. The work is to be completed by September 1st, 1885.

THE general winter meeting of the Institution of Permanent Way Inspectors was held on January 31st. The president, Mr. W. L. Meredith, C.E., of Gloucester, presided. After the confirmation of previous minutes, the secretary read a statement of accounts for the year 1884, being the first year's existence of the Institution. The nomination forms of twenty-nine persons were then considered, and twenty-eight elected. The selection of the best means of assisting the Railway Servants' Orphanage, Derby, was next considered. The president, the honorary treasurer, and secretary were each re-elected, and the election of a new committee took place. Manchester was selected for the next place of meeting in June.

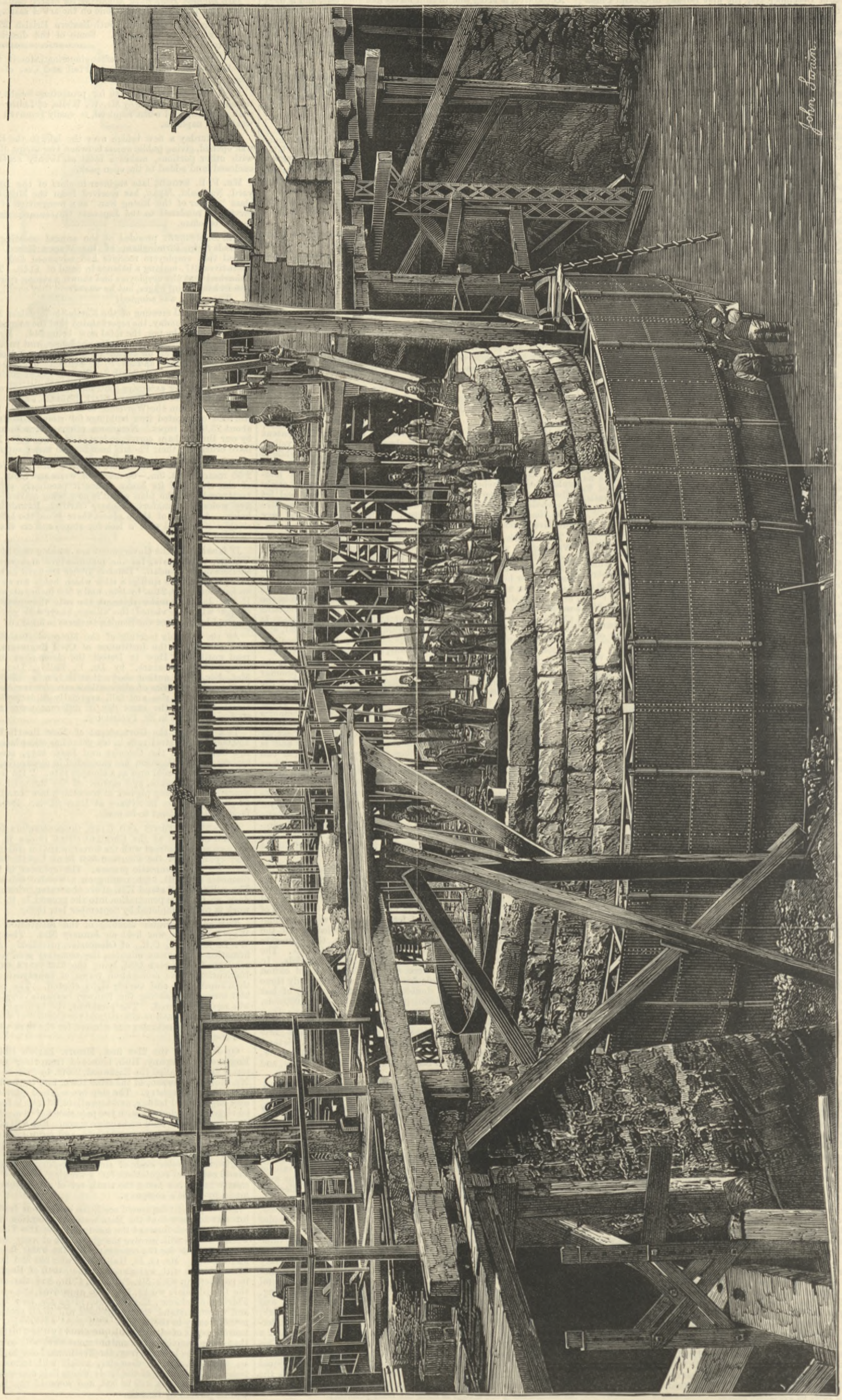
ON Saturday, the 21st inst., Messrs. Earle's Shipbuilding and Engineering company, Hull, launched from their yard a fine iron screw steamer called the Eastwood, 256ft. by 34ft. by 17ft., built for Mr. Robert Jameson, of the same town, and to the highest class in the Liverpool registry. The ship has a raised quarter-deck, bridge over engines and boilers, and topgallant forecastle forward, and will be rigged as a schooner with two pole masts of iron. Water-ballast is provided in after hold and engine space. She will also be provided with steam steering gear amidships, and screw gear aft. She is to be propelled by triple compound three crank engines capable of indicating 700-horse power, steam for which will be supplied from a large single-ended boiler made of steel in accordance with the Board of Trade rules and regulations for a working pressure of 142 lb. per square inch, this being the tenth set of triple compound engines made by Earle's company.

IN the present depressed condition of the iron trade it will be of interest to know that the Manchester Corporation have at length decided to push forward the construction of the Thirlmere Waterworks, which will involve the giving out of very large orders for cast iron pipes for the conveyance of the water from the lake to Manchester. Mr. G. H. Hall, C.E., who has had large experience in connection with waterworks in the North of England, and who, in partnership with Mr. Bateman, C.E., had the carrying out of the Longdendale works, has been appointed the engineer for the Thirlmere scheme; the requisite plans are now being prepared, and we understand that operations will in all probability be commenced early in the spring. One great advantage, from an engineering point of view, that is possessed by the Thirlmere scheme is that comparatively little embankment work will be required. The water is to be brought from the Thirlmere Lake to Manchester by an aqueduct 7ft. in diameter, which will follow as nearly as possible the contour of the land; where it is necessary to cross any valley syphon pipes will be laid, and some of the large mountains will be pierced by tunnels.

THE FORTH BRIDGE—MAIN PIER ON INCHGARVIE.

MESSRS. FOWLER AND BAKER, MM.I.C.E., ENGINEERS.

(For description see page 162.)



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J. H. L. (Crewe).—*Apply to the Marine Department of the Board of Trade, Whitehall.*

J. S.—*Unwin's "Elements of Machine Construction." Box's treatise "On Mill Gearing."*

H. E. (Borough-road College, S.E.).—*You must send more definite title or description of the designs you refer to.*

J. C.—*The information you ask for has already appeared in our pages at various times. You will find it if you will consult the indices to your volumes.*

H. C. F.—*You will find the information you require in Box's treatise "On Heat," which you can obtain from Messrs. Spon, Charing-cross, for a few shillings.*

G O. (Johnstone).—*Nearly all the patents that have been recently taken out for the improvement of safety valves have had the augmentation of lift for their object. We may direct your attention to Adams' "pop" valve and its many modifications.*

R. A.—*We fear that the demand for water velocipedes is too small to make it worth your while to spend much time on your invention. The principle seems to be correct enough, but it would require much thought and experimenting to bring it into a marketable shape.*

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Advertisements cannot be Inserted unless Delivered before Six o'clock on Thursday Evening in each Week.

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

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, March 3rd, at 8 p.m.: Ordinary meeting. Paper to be read with a view to discussion, "The Construction of Locomotive Engines, and some Results of their Working on the London, Brighton, and South Coast Railway," by Mr. Wm. Stroudley, M. Inst. C.E. Thursday, March 5th, at 8 p.m.: Special meeting. Third lecture "On the Theory and Practice of Hydromechanics—Water Motors," by Professor Unwin.

SOCIETY OF ENGINEERS.—Monday, March 2nd, at 7.30 p.m.: Paper to be read "On American Engineering Enterprise," by Mr. Arthur Rigg, Past-President. This paper will consist principally of general observations upon American machinery, with special reference, however, to their railways and locomotives, and also to turbines, many of which were seen by the writer. There will be descriptions of mining interests in Montaine and at Leadville, interspersed with various conclusions to which these matters give rise. The paper will be illustrated by five photographs of the Rio Grande Mountain Railway and other characteristic scenes; also by water-colour drawings kindly lent by Mr. John Dixon for the occasion.

ENGINEERING SOCIETY, KING'S COLLEGE, LONDON.—Tuesday, March 5th, at 4 p.m.: Discussion "On Lighthouse Illuminants."

SOCIETY OF ARTS.—Monday, March 2nd, at 8 p.m.: Cantor Lectures. "The Chemistry of Pigments," by Mr. J. M. Thomson, F.R.S.E., F.C.S., Lecturer on Chemistry at King's College, London. Lecture II.—Chemistry of blue, yellow, and red mineral pigments—certain organic pigments—special pigments. Wednesday, March 4th, at 8 p.m.: Thirteenth ordinary meeting. "The Evolution of Machines," by Professor H. S. Hele Shaw. Friday, March 6th, at 8 p.m.: Indian Section. "The Trade between India and the East Coast of Africa," by Mr. Frederic Holmwood, British Consul at Zanzibar. Major-General Sir Frederic John Goldsmid, K.C.S.I., C.B., will preside.

THE ENGINEER.

FEBRUARY 27, 1885.

LOCOMOTIVE ENGINE BOILERS.

THE amount of heating surface which the boiler of a locomotive engine possesses seems to exert but a limited influence on the powers of the machine; at least, while we find that in practice certain dimensions of cylinder and driving wheel are associated with comparatively well-determined loads and speeds, boilers of very diverse dimensions are fitted to supply these cylinders with steam. Again, no one thinks of making any difference between the boilers needed for 17in. cylinders, 24in. stroke, and 18in. cylinders with a 26in. stroke. What is big enough for one is big enough for the other. Further, we find locomotives with grates of various areas, the tube surface remaining unchanged. Mr. F. C. Marshall a few years since somewhat startled the engineering world by tabulating the dimensions of a large number of marine engines and boilers, and thereby showing that nothing like uniformity of practice existed in heating surface, condensing surface, grate area, or, in one word, in anything connected with the machinery employed to propel ships by steam. There is incontestably more uniformity in the practice of locomotive engineers, but there are still such apparent anomalies that we feel disposed to echo the late Mr. Beyer's words on a somewhat memorable occasion, and say, "anything will do for a locomotive."

It ought to be a fact that a big boiler will supply steam in greater quantity, and with more economy, than a small one, but it does not appear that this is really the case as regards locomotive engines. We might, for example, cite the Great Britain class of engine on the broad gauge Great Western Railway. These have probably the largest boilers ever used with passenger trains. They have 18in. cylinders, 24in. stroke, and driving wheels 8ft. in diameter. The tube surface is 1799 square feet, disposed in 305 tubes, each 2in. diameter. The fire-box surface is 153 square feet. The total heating surface is thus 1952 square feet, and 21 square feet of grate surface. The engine weighs empty 31 tons. We find modern engines with precisely the same dimensions of cylinder and driving wheels doing perfectly well and giving complete satisfaction with less than two-thirds of the nominal boiler power of the Great Britain; and there is no evidence available to prove that the broad gauge engines of the Great Western Railway were in any respect the better for having such enormous boilers. The Great Britain has indicated 950-horse power as a maximum. We may compare this with the Gladstone, on the London and Brighton Railway, engravings of which and a special report on its performance will be found in THE ENGINEER for October 19th, 1883. The Gladstone has indicated 1040-horse power. The total heating surface is 1485; grate surface, 20·65 square feet. Thus, the Gladstone has 467 square feet less than the Great Britain for rather more power. Taking the horse-power of each engine as, in round numbers, 1000, we find that 1·485 square feet develope a horse-power in Mr. Stroudley's engine; 1·952 square feet are required in Mr. Gooch's engine. This is a wide difference. The truth is that the locomotive boiler is a very peculiar affair, and that the quantity of steam which it can produce in a given time depends on many factors besides heating surface. Thus, for example, the dimensions of the short piece of pipe which in the lofty locomotives of the present day does duty for a chimney, have a most important influence; and we need hardly add that the dimensions of the blast pipe are all powerful in their effect on the generation of steam. We are speaking now, be it observed, without any reference to economy of fuel. We are considering the steam-generating power alone of a boiler—and it is not too much, we think, to say that very few people indeed know, or care to know, whether one type of locomotive boiler is more economical than another. So far as any facts are ascertained, it seems that heating surface is, in this respect, a secondary consideration as compared with good circulation in the boiler. For example, Mr. Adams, when on the North London Railway, built some engines with an unusually small number of tubes abnormally far apart—$\frac{7}{8}$in., we believe, instead of the usual $\frac{5}{8}$in. These engines, in spite of the reduced tube surface, made more steam and were more economical than their fellows. Locomotives which have steamed badly, have ere now been very much improved by the removal of a couple of dozen tubes. When a locomotive is running fast, with a fierce fire, the space among the tubes can contain little save froth if the tubes are closely packed together.

Thus, then, it appears that the power of a locomotive is within reasonable limits independent of the amount of heating surface in the boiler. There are strong temptations to keep down heating surface, because not only does it cost a great deal of money, but it is very heavy, and after a certain point has been reached weight is objectionable in a locomotive. There is, however, reason to believe that in not a few cases grates have been made smaller than they ought to be; for so long as there is a big grate a driver should never be at a loss for steam. For a big grate means a big fire-box, and fire-box surface is very much more efficient as a steam maker than tube surface. The first engines with 8ft. wheels and outside cylinders 18in. by 26in., designed by Mr. Stirling for the Great Northern Railway, were found not to make steam enough for heavy trains. The succeeding engines had about two more square feet of grate got by lengthening the fire-box a little, and there was no more trouble experienced. It is possible that the same end might have been attained by contracting the blast pipe; but such an expedient is simply barbarous, and will be tolerated by no locomotive superintendent save as a last resource; because while it enables the boiler to make more steam, the steam is wastefully employed, and the fire is cut up, and unconsumed fuel ejected from the chimney with much risk of setting fire to property along the line. The exhaust of a locomotive cannot well be too soft; and when plenty of boiler power is available the back pressure may be kept very small.

Notwithstanding all that may be said for and against big and little boilers respectively, no thoughtful engineer can, we think, fail to desire that some one shall formulate locomotive practice a little and supply definite information as to the best dimensions to be adopted for a given duty. It will not suffice for him to express merely his own opinion on this subject; there are nearly as many opinions as there are men. One will assert that less than 1700 square feet will not suffice for the performance of a certain duty, while another triumphantly refutes him by pointing out that his engines are doing this very work with 1100 square feet of surface. The whole question, if properly stated, would form an admirable subject for discussion before some of the technical societies or in our own pages. The problem to be solved is, given a certain amount of load and a given speed, how much heating surface will be required to do the work most economically? Thus, for example, let the load be 110 tons, exclusive of engine and tender, the longest continuous run 70 miles, the speed 50 miles an hour, including stops, the ruling gradient 1 in 270, the gradients compensatory; what is the proper amount of heating and grate surface for this duty, the fuel used being (1) Welsh, (2) North-country coal? What is the proper amount of heating surface to take goods trains weighing 350 tons, without engine and tender, at 20 miles an hour over the same road? On these points no one is better qualified to speak from experience than a man who has daily driven engines of different dimensions. As matters stand now, there is considerable diversity of practice among locomotive superintendents; and when every allowance has been made for the wonderful power of adapting itself to circumstances possessed by the locomotive boiler, there is still reason to believe that in some cases boilers too small, and in others, boilers too big for their work are used. There ought to be enough information floating about to enable a valuable result to be arrived at, if only those who can speak would each give his own experience. We shall be glad to see the question fully discussed in our correspondence columns.

WORKING HOURS AND TRADE DEPRESSION.

MANY causes have been assigned for the present depression of trade, and one or two remedies suggested. So far as the suggested causes are concerned in the present stagnation, the commonly accepted theory of foreign competition is, on the whole, the one most reasonable. The opponents of this belief, however, point to the fact that dulness of trade is cosmopolitan, prevailing with tolerable equality all over the world. This argument, however, as applied to Great Britain, is not quite sound. A particular nation, fortunate enough to possess a monopoly in some speciality, will thrive and prosper thereon, the same branch of trade either languishing, or being altogether absent from the list of industries in other countries. So soon, however, as a speciality ceases to be such, and becomes matter of competition, the former holder of it as a monopoly loses a percentage of the profits derived from it proportionate to the extent of the competition against him; and he suffers corresponding loss without perhaps any particular gain accruing to the competing countries. A certain amount is gained by a country when it is able to manufacture its own commodities at a less rate than that at which it could previously purchase them; but still the gain to it will be far less than the loss to the original monopolist. Thus we may, for example, select two industries to prove what we say. At one period, not very many years back, Manchester enjoyed a monopoly of cotton spinning and weaving. Fortunes were made speedily and with certainty; but those days are past, and Manchester trade is far less profitable now, simply because other nations spin and weave their own produce. It by no means follows, however, that American, or Indian, or French spinners and weavers are to become in a few years cotton lords. They have themselves to endure the very competition they have created. They are but a little better, while Manchester is a great deal worse off. The second case we may cite is our iron and steel industry. At no very remote period England enjoyed almost a monopoly of this trade and prospered exceedingly; now things are changed, and the change is not even yet complete. Belgium can in some sorts of ironwork undersell us even in our home market. Year by year the iron and steel industry of the United States is developing, and the unpleasant fact remains for us to face, that the gradual development of the iron industry in other countries, though benefitting them a little, does ourselves a great deal of harm. The conclusion to be drawn, therefore, is, that it is vain and idle to deny that much of the depression of our own trade is simply due to the fact that we have to face keen competition.

If we are to hold our own in the national race for existence every effort must be strained to reduce prime cost, and as the most important factor in this is labour, the working man must be brought to see that if he is to enable capitalists to employ him at all, he must be content to accept such a scale of wages as will leave a moderate profit on capital invested. Those wrong-headed and ignorant agitators who urge men to strike, and otherwise combine to force up wages, are really the very worst enemies the working man can have, as they virtually advise the driving out of trade from the country altogether. One of the great influences in manufacturing industries is time—time is essentially money. In a recent impression we published an abstract of the "Proceedings" of the Steam Engine Makers' Society, and we would call attention to Mr. James Swift's report to the members of that body, and to the views expressed by him. There are some matters of an encouraging nature in his report, for Mr. Swift tells his hearers that business depression is not universal. Machine tool makers are fairly busy; this is good, not alone for tool makers, but also as an index of a healthy state in trades using machine tools. He tells us that the locomotive trade is very brisk, makers having sufficient orders to keep them going for some time to come; and recent improvements in cotton machinery have made ample work for men accustomed to that branch of business. Mr. Swift's next remark is full of interest and instruction, and should be laid to heart. He says: "The general engineering and millwright establishments have not been so fortunate, as it is only those who have laid themselves out, by adopting modern tools and improvements, to meet present requirements, that have been able to keep a complete staff of men fully employed. Others who have depended upon their past earnings and a name or reputation for the good work formerly done, have found out that trade will not come to them unsolicited in the present competitive age, and as a consequence the more advanced firms have secured the few orders that have been in the market."

All this is instructive, and Mr. Swift deserves credit for the plain and outspoken manner in which he tells his hearers to be up and doing if they want to hold their own. He has, however, made some remarks about hours of work with which we cannot quite agree. He is of opinion that a reduction in the number of working hours would be beneficial to trade. Heretofore the invariable argument has been that one cause of the decadence of our trade was the reduction of our working hours below those of other countries. Mr. Swift holds precisely the opposite view. He says:—"Last year we discussed at some length in our report the need for a curtailment in the hours of

labour." We need not repeat here what we have already published, but it appears to us that Mr. Swift in some way misses his point. He draws a connection between his advocacy of shorter hours and the fact that a tendency on the part of employers to employ young in preference to middle-aged men yearly increases. We confess we fail to see the logical connection. Does Mr. Swift mean that long hours speedily wear men out and leave them useless? If so, why so? Business men are usually supposed to be only in their prime at forty or forty-five, and surely their work is more wearying and harassing than that of the artisan. If the artisan be worn out at the same age, the cause must be sought for in some other direction. We fear a percentage is due to drink, another percentage to unhappy homes, thriftless, drunken wives, &c. Shortening hours of work may not necessarily prolong a man's working powers; how his leisure is spent has much to do with the matter. Regarded from a financial point of view, if trade is slack no doubt the wisest course, as well as the one most humane, is for employers to shorten hours rather than reduce their staff. In winter especially it is cheaper to employ a full staff during all available daylight, as the gas bill is kept down and the work done is of better quality. This system is largely adopted in the United States, but nevertheless there are longer hours worked there when there is work to do than there are perhaps in any other country on earth. In the States there are no Saturday half-holidays, no Bank, Christmas, or Easter Holidays. If Mr. Swift comments on the difficulty men experience in getting employment once they pass forty, he ought to tell us something more than this. It would be alike interesting and instructive if Mr. Swift, being, as he is, a man alike able, and conversant with labour questions, would during the next twelve months glean all the data he can compass concerning the reasons why, as he tells us, railway companies, corporate bodies, and even private firms dislike to employ middle-aged men. If he would do this, both himself and his hearers or readers would be in a better position than that now held to form an opinion as to the real nature and extent of the influence exercised on national industry by the ages at which employers prefer to engage their operatives, and how much actual connection exists between this question and the number of hours worked in any given industry. Perhaps on investigating the subject Mr. Swift might, we do not say would, but he might, find that employers preferred young men because they were more docile, and less given to strikes and wages disputes than their elders. That being to some extent learners of their trades, the young men would simply attend to mastering their business; content to leave attendance on spouting agitators, party political speakers, and the general business of disturbing friendly relations between employers and their men, to the older folk. That, in point of fact, young men are preferred because they mind the business at which they get their living, and older men do not. If we look at the working hour question from an abstract point of view, and suppose, just for illustration sake, that all the available work of manufacture in, say, England, can be executed in each period of 1000 hours by 100 men. Regarding this from a purely philosophical point of view, it cannot, we apprehend, much signify to the country at large whether 100 men are employed ten hours a day to do a given amount of manufacture, 200 men for five hours a day, or 250 for four hours. But it must not be forgotten that if each man of the 250 gets as much wages for four hours' work as each man of the 100 would get for ten hours' work, then the cost of labour will be augmented two and a-half times, and the consumer of the manufactured article will have to pay the additional sum. The lessening of output in order to increase prices is a very favourite scheme with men like Mr. Swift, but they never regard with favour any proposal to reduce the number of hands or the amount of wages in the same proportion. In one word, their view is that, wages remaining constant, two men should be employed to do what is now done by one man. This takes no account of foreign competition; and returning to our illustrative hypothesis, it should be evident to Mr. Swift that in any case the quantity of work available, and the number of men to be supported by it, remain the same; time and the rest of the question are simply matters of distribution of work-time and play-time. Either all may equally divide the work and the play, and each individual support himself, or else some may have all the work and be forced, through the trades union, to support the players. In either case, however, the result to the nation at large remains the same. In other words, if half the nation is idle and supported by the other half who are working full time and getting full wages, the average prosperity of the nation at large is much the same as if all are working half time at half wages; and with the utmost respect for the views of so able a man as Mr. Swift, we must express our opinion that when short hours' doctrines are preached, we must, as a nation, have but a limited amount of work to do; or else, having enough, we are getting too lazy to do it; and either condition argues badly for our national prosperity. But under no circumstances can a whole day's wages be paid for a half day's work, which is the real meaning of reduced output as defined by Mr. Swift.

IRRIGATION IN ITS LATEST ASPECT.

That every question has two sides is a well-established fact; and it will therefore be no surprise to our readers to learn that late intelligence received is calculated to disturb those optimist views which are so currently held with respect to the benefit accruing from the large outlay on irrigation works made of late years by the Governments in our Eastern possessions. When the late General Cotton's proposals for carrying out an extended system of this nature in the Madras Presidency were first published, the figures given by him seemed most alluring. Companies were at once formed, and a large expenditure was made to carry out the General's views; but the result has been but a very limited return, and it has generally been acknowledged that large schemes of this kind have in no way fulfilled the anticipations of their promoters. Some of our readers were perhaps present at the reading of a paper by Mr. Mosse, M. Inst. C.E., on the subject of the irrigation works which have been carried out in Ceylon, before the members of the Royal Colonial Institute. In that paper, and by several speakers during the discussion which followed the reading of it, statements were made which described in the most *couleur de rose* terms the beneficial effect which had attended the execution of works in districts subject to frequent drought; and had it not been for the counter assertions of one speaker only, those statements would have remained unquestioned, and the propriety of further proceeding in the same course so far established.

But one gentleman had the courage of his opinions, and spoke with much point against the assumptions which had been made; and we have lately received evidence of the strongest character to support his contention that all was not so well as seemed apparent. Notable among the opinions expressed on the occasion referred to were those of Sir William Gregory, who at one time filled the office of Governor of Ceylon. It will be remembered how self-congratulatory were the statements made by him; for he claimed—and justly—to have been among the foremost to sanction outlay upon irrigation. He described in glowing terms the wonderful results he had observed from such outlay during a revisit to the colony several years after the expiry of his term of office. Every possible benefit, according to him, had followed his endeavours in this direction. Disease of a horrible character, long prevalent in the district dealt with, had died out, and even the babies had acquired a plumpness remarkable even among babies. It must have been rather shocking to Sir William Gregory to read in the columns of a local paper that Sir Arthur Gordon, who had just returned from a tour through the same district, had had "created in his mind a feeling of surprise and indignation at the sad state of things which he found—so different to the glowing picture which had been painted for him. Instead of a teeming population he found a sparse one, and these dying of fever from bad or insufficient water."

Truly we have here the other side of the picture. In the district referred to, Sir William Gregory had expended very large sums in the restoration of the gigantic works for water supply constructed by the native rulers of the land very many centuries back, and, as it now appears, we may well ask, *Cui bono?* It will be our object to point out the error which seems to us to be the primary cause of this utter failure of an attempt to improve the condition of the agricultural population; and it will be well if those entrusted with the present government of Ceylon learn a salutary lesson, and impose some check upon an ill-regulated and ill-timed—considering the present state of the colonial revenue—expenditure upon works of this class. It is undoubtedly the case that the works undertaken have been of too grandiose a character. There is no fault which the governors of our colonies are more prone to commit than to try and perpetuate their names by associating them with gigantic public works, and many of them—including Sir William Gregory and several of his predecessors—have been led by this personal desire into mistakes for which the tax-payers of the island have been heavily mulcted. As Mr. Mosse informed us in the interesting paper read by him, ancient rulers in Ceylon left behind them monuments of undying fame in tanks of vast magnitude, forming almost inland seas, which were intended to guard against water famine; but in their construction by forced labour the population which was to avail itself of their benefits was killed out by the hardships imposed. In the vain hope that the restoration of such tanks would bring back that population, the energies of successive governors have been devoted to this object; but the results, as we learn by our contemporary quoted, have been most disappointing. It is as well that the fact should at once be acknowledged, that all such attempts are a mistake in policy, and the sooner they cease the better. Other means must be sought if fever is to be driven out and population eventually re-established, for it is certain that the natives will not willingly leave healthy for notoriously unhealthy districts on the mere inducement of a lavish water supply for lands, centuries out of cultivation, and now covered by dense jungle growth.

It is, we contend, to the gradual amelioration of the condition of those who still cling to their ancestral homesteads, and to the consequent natural increase in their numbers, rather than to emigration from other localities, that we must look for the re-population of the districts which have suffered as we have named. Now each such homestead or village possesses its own small tank of perhaps immemorial antiquity, but the gradual dwindling of its inhabitants, as well as the natural apathy of the native where his efforts are not stimulated or directed by authority, have tended to many of these falling into disrepair, and the evil effects resulting in shortness of the food supply have helped to bring about the propagation of the fatal "parangi" disease which annually claims its thousands of victims. It is in this direction, in aiding these impoverished people to restore the village tanks, that money expended will show its return. We do not wish it to be thought that nothing of this character has been attempted. Such an attempt has been made, and always, as we understand, with direct benefit apparent; but much more, and on a more liberal scale, remains to be done. If a tithe of the many thousands which we fear we must say have been wasted both in India and Ceylon, in order that Governors might leave their mark behind them by renewing the fallacious glories of an almost forgotten antiquity, had been spent in assisting the humble ryot or coolie to earn a sufficiency of daily food, we should not, we feel sure, now have to record the "surprise and indignation" felt by Sir Arthur Gordon over what he has seen in the North-Central province of the colony he rules over. It is high time some better acquaintance with the true results to the prodigality of local governments over these matters should be acquired by and weigh with the supreme authorities at home; and it is to be hoped that, failing Sir Arthur Gordon laying the lesson he appears to have learned to heart, they will direct such searching inquiry and report as shall stay further wasteful expenditure upon works proved to be both socially and financially unremunerative.

THE CONDUCT OF EXPERIMENTS.

We had occasion some time since to call the attention of our readers to the precautions which should be taken, and the difficulties to be overcome in carrying out tests for evaporative efficiency of steam boilers. Only those who have tested steam engines with a like object can fully realise how easy it is to get a false, how difficult to obtain a trustworthy result; and we propose here to supplement what we have already said by a few hints on this matter, one of considerable importance to consulting engineers who are frequently called upon to examine and prepare reports on the efficiency of steam machinery. Let us suppose that the arrangements for testing the boiler or boilers are all right, that nothing has been left to chance or uncertainty. The true weight of steam obtained in return for each pound of coal burned is known. The next thing to be ascertained is the amount of work done by this steam. The efficiency of a steam engine can always be expressed in terms of the weight of steam used per horse-power per hour. In the way the merits or demerits of an engine can be appraised without qualification by the merits or demerits of the boiler. Thus a very good engine may be combined with a very bad boiler, or *vice versa*. When we speak of the number of pounds of coal used per horse power per hour, the boiler and the engine are mixed up inextricably; but when the merit of a boiler is determined by the weight of steam which each pound of coal will produce, and that of the engine by the power which each pound of steam will develope, no confusion results. Tests of both boiler and engine can be carried out at the same time, or as is often more convenient, the boiler can be tested one day, the engine another; and this method has the advantage that a smaller staff is required. The engineer and his assistant will suffice, whilst if both engine and boiler are tested at the same time, the engineer ought to have two assistants.

There are two methods available for testing an engine: one is by the indicator, the other by the brake. Now and then the two are combined, and before going further we may here direct attention to the report on experiments made with a Corliss engine at Creusot, which will be found on page 159. Here the indicator was combined with a brake, and the arrangements were all made with an abundance of precaution which renders the experiment very instructive. The second system is in practice only applicable to engines of small power—say up to 200-horses at most. For although brakes of very great power have been proposed, and even made, such things are by no means generally available. The brake carries a constant load, so that the engine is run under very favourable conditions. In all cases where tests are made care should be taken to keep the load as uniform as possible, no matter how the engine is employed. When an engine drives shops full of tools which are constantly being thrown off and on, a very considerable number of diagrams must be taken, at least one from each end of the cylinder every quarter of an hour. The first point to be considered is the nature of the brake rigging, and as a rule, this will be found defective. We need not stop to explain here—because everyone who can use an indicator at all is supposed to know it—that it is essential that the motion of the indicator card should be identical with that of the piston. This it cannot be unless the card leads directly from the working lever of the rigging to the indicator drum. The best lever that can be used is one suspended from the point of an A frame bolted to the guide bars. Opinions differ as to whether the end of the pendulum lever ought to be driven by a short connecting rod or by a slot and pin. When great accuracy is necessary, the end of the pendulum should be connected to the crosshead by a long connecting rod. If the slot is used, care should be taken that there is no shake between the pin and the sides of the slot; and the A frame, the pendulum, its pins and joints ought to be very substantial, as the strain is much greater, especially with quick running engines, than seems to be commonly supposed. It is very usual to fit indicator pipes leading to the centre of the length of the cylinder with a two-way cock, by turning which to the right or the left, communication is made with the indicator and the front or back end of the cylinder. Too close a watch cannot be kept on the three-way cock. Some months since we carried out a test of a horizontal compound non-condensing engine indicating about 220-horse power. Several diagrams were taken, and the experiment had proceeded quite satisfactorily for nearly two hours, when a comparison was made of the high and low-pressure diagrams. It was then found that the back-pressure in the high-pressure cylinder was higher than the initial pressure in the low-pressure cylinder by much more than was anticipated. The springs were carefully examined and changed, but without effect. It was only after some investigation that it was discovered that the three-way cock had worked very stiffly, and the screw holding it down had been slackened. The result was that the cock rose and fell in its seat as the pressure varied, and that it leaked steam into the indicator to such an extent that the piston of the indicator never fell far enough. The whole trial was, of course, worthless up to that point, and a second test on another day became necessary. Here was an error, it will be seen, of a very subtle character. The terminal pressure in the small is always higher than the initial pressure in the low-pressure cylinder unless there is great compression—a most unusual circumstance—and not the least evidence of compression was manifest in this case. If the difference had only been a little less considerable it would have passed unnoticed, and the results obtained would have been erroneous, and no one would have known that they were. Another point to be carefully guarded against is giving the drum so long a stroke that it comes against the stops. A trustworthy result cannot be got; and here we beg to anticipate the objection that may be raised to the effect that the blocking of the drum against the stops cannot pass unnoticed. This is quite true if the stroke is much too long; but it may exist to a

small degree, and none but those possessing considerable experience in diagrams will be a bit the wiser. Our purpose, above all others, in writing this article is to call the attention of our younger and more inexperienced readers to the importance of guarding against *small* errors; the large errors may, in one sense, be always left to take care of themselves. They will obtrude themselves on the observer's notice; not so the little inaccuracies. They must be hunted out and eliminated. While on this matter of drum blocking, we may add that it is sometimes permitted to take place purposely by unscrupulous individuals who wish to get beautiful diagrams with defective valve gear. It is when properly worked an admirable device for getting square corners; and we have ourselves obtained entirely different diagrams from those submitted to us in the first instance as samples of what a given valve gear could produce. We do not say, of course, that in this case there was any wilful dishonesty, but there certainly was carelessness. In general the thing is overdone, especially at the other side of the Atlantic, and experienced engineers are not to be taken in; but many steam-users know just enough about a diagram to be deceived by the beautiful square corners which may be had by the use of a slack string.

In testing with the dynamometer very anomalous and erroneous results can be obtained either at pleasure or inadvertently. The dynamometer consists of a smooth-faced cast iron pulley, a usual dimension being 3ft. 6in. diameter and 5in. wide on the face, but they are made of all sizes. Round this pulley is passed a species of belt made of hoop iron—generally two hoops side by side—and this belt carries six to twelve segmental beech blocks. An arrangement of balance levers is so introduced that when the hoop is carried round the wheel in one direction it is tightened on it, while if moved round in the other direction the blocks relax their grip. At one side of the wheel is suspended a scale pan which can have weights put into it. When the brake wheel is caused to revolve by the engine whose power is to be tested, it tends to carry the hoop with its segments round with it, thus slackening the hoop; but the carrying round of the hoop is resisted by the weights in the scale pan. The wheel then revolves within the friction blocks, usually of beech, and careful lubrication is necessary to prevent them from firing. If the lubrication is too profuse the weight overcomes the friction of the hoop; which then turns round on it in a direction opposed to its motion. Then the balance levers before referred to tighten it up and restore equilibrium. The coefficient of friction we need give ourselves no concern about. The resistance is measured by the weight in the scale pan multiplied by twice its distance in a horizontal line from the centre of the axle, and by 3·1416. Thus, let the distance from the centre of the brake wheel to the centre of the point of suspension of the scale pan be 2ft., and the weight 200 lb., and the revolutions per minute 150, then we have H.P. $= \frac{2 \times 2 \times 3{\cdot}1416 \times 200 \times 150}{33{,}000}$

= 11·4 H.P.

Two principal points have to be attended to in dealing with brakes. The first is that the distance from the centre of the shaft to the centre of suspension of the scale has to be ascertained with minute accuracy; the second is that the imaginary line uniting these two should be always horizontal. To effect this object, two pointers are provided; one projecting from the point of suspension of the scale, and the other from a fixed upright set in the frame of the brake, and these must be kept as accurately as may be opposite each other. If the point of suspension of the scale rises above or falls below the vertical, the load on the brake is reduced. Care should also be taken that the friction blocks are equally distributed round the wheels. If there are too many at the back of the hoop iron belt, that is to say, at the falling side of the rotating wheel, then the load on the engine will be less than it seems to be. The dynamometer never should be driven by a belt when it is possible to avoid it, because slip comes in and falsifies the results, the engine then doing more work than the brake gives credit for. There are various little "dodges" that can be employed to make a dynamometer or friction brake give too high a result, which are familiar to those who are experienced in the use of the machine; but, on the whole, the dynamometer or friction brake is very honest, and does not lend itself readily to deception of any kind. It is, in experienced hands, more trustworthy than the indicator. It is to be regretted that it cannot be more frequently employed.

A NEW DEPARTURE IN GUN FORGINGS.

IT is evident that the makers of heavy forgings for the manufacture of guns have determined upon closing the mouths of those who say that English firms are unable or unwilling to move with the requirements of the times. The Sheffield manufacturers contend most stubbornly that they have always been able to supply, and have, in fact, supplied, every requirement asked by the Woolwich authorities or by other people. Addressing his shareholders on the 20th instant, Mr. T. E. Vickers—Messrs. Vickers, Sons, and Co.—repudiated the idea that Sheffield cannot supply heavy forgings for ordnance, and was generally behind the age. These statements, he said, had no foundation in fact, and were made by writers who had no real knowledge of the true state of things. In proof of this he stated that his own firm had made forgings 40 per cent. heavier than the heaviest which had so far been required by the Woolwich Arsenal or by Sir W. G. Armstrong, Mitchell, and Co. Mr. Vickers' declaration is that of other Sheffield firms. It is clear, however, that they are not content to let affairs stand as they are. A considerable controversy took place in the *Times* last December and January as to the lack of heavy hammers in the English establishments contrasted with the powerful appliances of that kind in the Creusot and Essen works. It is certainly a fact that in Sheffield the heaviest hammer is 30 tons, but this is not owing to any deficiency of enterprise. For some time the heads of the different firms have been satisfied that in the manipulation of large masses of steel there were undoubted advantages in forging by the press instead of by the hammer. Mr. Vickers stated frankly on Friday that as soon as his firm was satisfied that there was probability of a trade in large masses, they commenced making one of great dimension, and his shareholders had an opportunity of inspecting it. Messrs. Charles Cammell and Co., Messrs. Thomas Firth and Sons, Messrs. John Brown and Co., are all taking similar steps. At the Grimesthorpe Steel Works Messrs. Cammell and Co. are erecting a special building for their forging press, which is to have a power of between 4000 and 5000 tons, with two cranes to lift 150 tons each. These extensions of facilities for the production of gun forgings mark a new departure in this great industry, and it may be noted that the Elswick firm are making similar preparations. They are now having finished for them an immense forging for the cylinder of a forging press they are about to erect. Sir W. G. Armstrong, Mitchell, and Co. have been in the habit of getting their heavy forgings from Sheffield, and have done an important business with two leading firms there. Now, however, they are taking steps to do the work at home. In Sheffield alone the expenditure involved in forging presses and necessary adjuncts will approach £250,000. Mr. Vickers joins with other Sheffield manufacturers in ridiculing the idea that sound ingots can only be made by what he calls "the so-called invention for the fluid compression of steel." He declares the process to be theoretically and practically useless. It is, he admits, an impressive process on the minds of unsophisticated spectators, as the outburst of gases from the material with which the mould is lined appears to them to be pressed out of the steel, and they go away with their minds well charged with the advantages of the process. "I have good evidence," sarcastically adds Mr. Vickers, than whom no one is more entitled to speak as an authority on high-class steel, "that the process is of no value, except for giving this impression;" which remark is "rough" on the process as well as the "unsophisticated spectators."

THE FAILURE OF THE SHIPPING BOUNTY SCHEME.

IT must be gratifying to English shipowners to find that the encouragement of foreign mercantile marines by bounty systems has so far everywhere failed. The same report comes from France, from Germany, and from America. A merchant navy cannot be established nor increased except under conditions naturally favourable to it, and even then it is of slow growth. To build steamers fit to compete with others on the world's highway means the utilisation of an immense number of products and facilities which are found in very few places indeed. The locality must be the banks of a navigable river. Near at hand iron or steel works must be in operation, and not far from these there must be mines of iron and coal. A good labour market is also indispensable. Not only unskilled labour in unlimited quantity must be forthcoming, but also skilled labour of various kinds. Platers, riveters, smiths, fitters, carpenters, joiners, riggers, and so forth must be had just when they are wanted, and only so long as they are wanted. Timber of all sorts, wire and hemp rope, rivets, bolts, nails, spikes, castings, wrought iron and brass fittings, ironmongery, and so forth must be quickly obtainable. It will not do to go far afield to get these things; they must be close at hand when wanted, and at the lowest market price. Then, again, there are other complicated and delicate and yet most essential requisites in the propelling machinery, the steering machinery, the hoisting machinery, and so forth. These must all be procurable in the neighbourhood, must be of the very best kind known, and at the lowest possible price. A steamer of inferior build, or ill found in any essential respect, could not compete. A steamer, for the building of which the materials or appliances had to be collected from over a wide area, would cost too much. Then, again, as to management of a steamer or fleet when built, similar conditions are essential if success is to be obtained. A choice of captains, engineers, sailors, and other officials is desirable. Local and technical knowledge must be had, not only as to nautical matters, but on commercial and geographical points. Indeed, wherever shipbuilding and shipowning has taken root and flourished the natural conditions are favourable, and the other conditions have taken many years to develope. No system of bounties, however lavish, can make up for their absence. As well might a farmer attempt by excessive feeding to make his calves and his colts full-grown animals before the natural period of growth was complete, or under conditions unfavourable to animal life at all. Forcing nature is sure to result in failure wherever tried sooner or later. Shipbuilding and shipowning in all countries where these industries are coddled have suffered from the bad times as much or more than in our own. Their present condition is worse, and their future condition need give us no concern whatever. On our northern rivers shipbuilding is once again on the increase. Neither owners, builders, or suppliers of materials are making any profit. But they are beginning again to be employed. And what is of perhaps more real importance is that our workmen are again finding occupation. In view of the extremely low price of the necessaries of life—that is, in view of the largely increased purchasing power of every sovereign paid in wages compared with a year or two since—no workman in full employment is now in the least to be pitied. He is, indeed, as well off currently as ever. Retrospectively he is a sadder, and in respect of the future he should be a wiser man. Let us hope that the favourable turn which appears to have come may continue, and that before the present year closes shipbuilding and shipping may be fully restored to the activity and vigour which characterised them two years since.

THE SOUDAN RAILWAY.

THE construction of the Suakim railway has in its favour the direction by men accustomed to the work, and some of them to the disagreeables of hot and troublesome climates with difficulties sharpened by the doings of hostile natives. Messrs. Lucas and Aird have so very large a staff, and are so fully alive to the wisdom of employing the best men, that they have had no difficulty in drafting a few from their extensive works in different places. Mr. B. P. Ellis and Mr. C. Lucas, jun.—members of the firm—left Charing-cross station by the 7.40 a.m. train on Friday, Feb. 20th, *en route* for Suakim *viâ* Brindisi. They will represent Messrs. Lucas and Aird until the railway work is in full swing. The permanent representatives of the firm who left by the same trains are Mr. John Blue, who, with Mr. H. L. Stannard, will have charge of the construction of the line; Mr. Arthur Beale, who will have charge of the telegraph and pipe laying; and Mr. H. B. Tarry, who will superintend at Suakim the receiving and forwarding of all material and stores required at the front. Mr. John Blue has served the firm on several important railway works in England, including the Maidstone and Sevenoaks Railway, and the Kettering and Manton Railway. Mr. H. L. Stannard has recently returned from the Brazils, where he has for about three years been engaged on the construction of the Natal and Noza Cruz Railway. Prior to that he was engaged for two years in the interior of Australia, where he went after having spent two years on the construction of the Putney Bridge (District Railway), and on the Acton and Ealing Railways. Mr. Arthur Beale has been for many years engaged for the firm on the Amsterdam Waterworks, and on other similar undertakings. Mr. H. B. Tarry has recently had charge of a section of the Hull an Barnsley Railway, and previously he had charge of the works for the construction of the Ipswich and Felixstowe Railway, and the Earl's-court and Putney Bridge Railway. The men selected are only about one hundred in number, though hundreds of Messrs. Lucas and Aird's thousands of men have been anxious to be put on the work, and seem to have as much desire to have a brush with the Arabs as to construct the railway. It seems, however, that the hundred selected will be expected to act as English navvies usually do when they get amongst natives like those of the Soudan—namely, want each of them to direct a small army of the natives. It is to be hoped that the men sent out by Messrs. Lucas and Aird will not be hampered by red-tape notions of how to do railway work. A considerable number gathered at the station on Friday morning last with those of the staff who left for Suakim, amongst whom were Messrs. C. Lucas, sen., John Aird, jun., W. Colson, A. C. Priestley, R. C. Barnard, W. Gill, H. B. Tarry, Mr. Arthur Stannard, and many others, either connected with the firm or related to the travellers.

INDUSTRIAL EXHIBITION AT SHEFFIELD.

IT was stated in THE ENGINEER last week that the Cutlers' Company, of Sheffield, had under consideration a proposal to hold an exhibition illustrative of the handicrafts of that town, with a view to stimulating excellence of workmanship, as well as showing to the world the progress which has been made of late years in every department of local industry. It is now definitely decided to carry out the scheme, and the Cutlers' Company has made arrangements to that effect. The Duke of Norfolk, who is lord of the manor, has joined the committee, and given a contribution of £500 towards the object. The Cutlers' Company grants the free use of the rooms of the Cutlers' Hall, and has also subscribed handsomely towards meeting the expenses of the Exhibition. It is expected that the display will be unusually interesting. It will include all trades carried on in the district of Hallamshire, which extends for several miles round Sheffield. In many of the trades goods pass through several distinct processes before being finished, and in this instance the exhibitor will compete in respect only of the particular class of work performed by him. Finished or unfinished, his work will stand by itself, depending on its own excellence, without regard to the other processes through which it may have to pass before completion. The object of the Cutlers' Company, its master—Mr. J. E. Bingham—having initiated the scheme, is to encourage the artisans of the town to the highest possible skill in their various crafts. It is expected that the Exhibition will, in many respects, be a practical reply to the disparaging statements freely made regarding industrial progress in Sheffield. Liberal money prizes are to be offered, and certificates for good workmanship will also be given. It is probable that the Exhibition, for which £1200 has already been subscribed, will be open for a month, from June 15th to July 15th.

COST OF HAULAGE BY FIRELESS LOCOMOTIVES.

THE paper read before the Institution of Civil Engineers last week on the Metropolitan Railway, by Mr. B. Baker, gave some account of the fireless locomotives made, but not used, about twenty years ago for the working of the Metropolitan traffic. Years have gone by, and it seems now probable that the fireless locomotive will take a prominent place amongst tramway motors where the proprietors have spirit enough to adopt the system in full, so as to employ and keep in work a large battery of steam boilers. The system cannot work economically where but one or two locomotives are used, and the fixed steam boilers are idle the greater part of their time, but there is perhaps no system better calculated to give good results where a complete set of plant is systematically employed. According to the statements of the Compagnie des Tramways du Département du Nord, the cost of traction by the Francq-Lamm engines on the Lille and Roubaix line, during January last, was 0·195f. per car per kilometre or about 3·2d. per mile. This is given as equal to 0·02f. per kilometric ton, or per 2200 lb., per kilometre, or say 0·3d. per ton per mile, while the cost per seat is given as 0·005f. per kilometre or 0·08d. per mile. These figures are higher than for previous months, January having been a very unfavourable month for working a rural line with heavy gradients and sharp curves, with snow lying on the rails and ordinary vehicles seeking the rails for easy running. The tramway was, however, constantly and regularly worked, and the extra cost of haulage the only effect of the weather.

OUR RAIL EXPORTS.

THE decline in the rail exports noticed last year has continued in the first part of the present, though it is probable that the orders given out for large quantities for military purposes will influence the return for the next two or three months. In January we exported 1269 tons of iron rails, an increase of about 430 tons on the quantity for the corresponding week of the past year; but of steel rails we exported only 26,563 tons, a decrease from the corresponding month's quantity last year, and a decrease to the large amount of 12,000 tons, whilst it is very much more if compared with the quantity for the month of the year preceding. The fall in the exports of steel rails is marked both to Europe and to America. No steel rails were sent last month to the European countries that are specifically enumerated, and the quantity to the United States, Mexico, and one or two other countries shows a decrease of some moment. In the value of the export there is not so much change, but it is remarkable that there is now little difference between the declared value of the iron rails and that of the steel rails, whilst for the past month the average was greatest on the part of the former kind. It may be hoped that the long decline in the rail trade has now attained its fullest extent, and that there will be soon a recovery, though it must be acknowledged that the source is not quite so clear. But with the cheap rails that we have there should be soon more customers: and there would be if the political and financial outlook were more settled.

THE AFRICAN INTERIOR SEA.

IT does not seem that Colonel Roudaire's scheme for an inland African sea is to be dropped in consequence of his death. A few days ago a party of engineers and hydrographers set out from Marseilles for Tunisia, charged with instructions to make all necessary surveys for the creation of a port in the Gabès Bay, at the embouchure of the Oued-Melah, where, says the *Moniteur Industriel*, the future canal destined to establish a communication with the Mediterranean will commence. It is also said that this expedition will be occupied in sinking artesian wells, and with a survey for a railway, which it is supposed will eventually be seen to be necessary. The expedition is directed by M. Commandant Landas, Professor of Topographie at the Ecole de Saint-Cyr, who is thoroughly conversant with all the work of the late Colonel Roudaire, and who has sought permission to complete the survey and other work commenced by him.

There is no doubt that M. Landas may obtain information which will have value in the probable great importance of the dark continent, but whether inland seas have sufficient value as obtaining conditions which could not be obtained by means which would not involve the loss of so much land, is a question which will be discussed before the water will be permitted to enter the great tract of the Sahara, even if surveys show the scheme to be feasible.

LITERATURE.

Hilfsbuch für den Schiffbau. Von Hans Johow. Berlin: Julius Springer. 1884.

This is undoubtedly the best hand-book yet compiled for the use of persons engaged in the design and building of ships. It is comprehensive in its scope, exceedingly well arranged, and gives a large amount of useful information in a comparatively small space. Like all works of the kind, it claims no originality, except that displayed in the compilation and arrangement of facts and figures; but it surpasses all previous attempts in this direction in its cosmopolitan spirit and extensive research. An English version of the book would be likely to obtain a considerable success, and be welcomed in the drawing-offices of our shipyards.

The work is arranged in five divisions. In the first is grouped a miscellaneous collection of useful information—mathematical tables and processes, tables of weights and measures, particulars of weights and strengths of materials, and brief statements of a practical character relating to heat, chemistry, and galvanism. There is also a section on the elements of construction, or, as we should preferably describe it, the "designing of details."

The second division deals with the theory of shipbuilding—the principles of buoyancy and stability, as well as the methods of calculating those elements in a design for a ship; the theory of the rudder; rules for estimating the horse-power required for given speeds in steamships; rules for adjusting the sail drawings of ships; the theory of wave motion in the deep sea; and the rules for the correction of compass deviation in iron ships.

In the third division the practical side of ship construction receives detailed notice. Rules for freeboard and tonnage measurement; details of masts, rigging, anchors and cables, boats, artillery, &c., and other matters where experience is of value in the outfit of ships, are all dealt with in an admirable manner.

Following this comes a division devoted to the propelling apparatus of steamships, which is an excellent summary of engineering practice, dealing in succession with the measures of engine-power, the various types of marine engines, the rules in common use for boilers, the various kinds of propellers, and the speed trials of steamships. The fifth and last division contains a large amount of information as to the rules enforced in Germany and elsewhere in connection with merchant shipping legislation.

This brief notice only indicates the great range of the information collected in this book. It is not to be expected that, in compiling and arranging such a mass of facts and figures, some errors may not creep in; but on the whole, in accuracy as well as in quantity of information, the volume bears favourable comparison with any book of a similar kind known to us.

Recommendations of United States Gun Foundry Board on Proposed Addition to the Establishments of the Gun Factories in the United States.

Since the above was written, a supplementary report was transmitted to the Senate by President Arthur in a message dated 22nd December, 1884.* The Gun Foundry Board, consisting of the same officers as before, had been directed to (1) Prepare places for Gun Factories for the Army and Navy, for ordnance from 6in. to 16in. calibre. (2) To state whether guns should be made by the Government or by private firms, or by the two combined. (3) To find out the best method of procuring steel for ordnance.

The Board considered it best to have distinct Government Gun Factories for the military and naval services, but that gun steel should be supplied from the makers of their country.

The Board split itself up into two committees, one for the Army and one for the Navy Gun Factory. The gun-making establishment for the former is proposed to be at Watervliet Arsenal, from plans suggested by Messrs. Greenwood and Batley, Leeds, England. The naval officers wish their factory to be at the Navy-yard, Washington, where it would be necessary to buy more ground, in order to obtain good foundations. Great assistance was derived from the study of designs of the new machines' shop of American manufacturers. Each committee gave a list of tools, &c., required, and estimates of cost. At least two years will be required to build and equip these factories, and some 2,000,000 dols. will be needed for the purpose; but even that amount will not provide everything necessary.

With regard to the supply of steel for guns, the Board received assistance from the secretary of the American Iron and Steel Association, who addressed a circular letter, dated 1st November, 1884, to the leading steel makers in the United States, in which he wrote that "the interest taken by Congress in its last session in the general proposition to establish in this country the manufacture of modern steel guns, leads to the inference that this branch of the Government will, at its next session, take definite action, providing a liberal permanent appropriation for the supply of material for the manufacture of these guns." It would appear that the United States are now determined on progress, as, although the Gun Foundry Board is very decidedly of the opinion that gun material should be developed in their own country, the English firm of Sir Joseph Whitworth and Co. have received orders for the steel for guns of 10in. calibre, which cannot yet be made in America. A sum of not less than 15,000,000 dols., in addition to two millions already mentioned, is suggested by the Board as sufficient to cover the cost of steel guns for the next six and a-half years; but certain annual expenses are not included in this amount.

It is proposed that the steel makers of the United States who may agree to supply the Government are to deliver yearly a certain quantity for each calibre, the time of delivery for the smaller natures to begin at not less than eighteen months, and for the larger ordnance not less than three years, from the date of the acceptance of the contract. These considerable periods are doubtless allowed to enable the makers who may take up the contracts to have time to erect the necessary plant. The manufacture of armour is also proposed. It thus appears that the Government of the United States seriously contemplates a large expenditure on the newest and heaviest ordnance, At the present time the need for numbers of modern heavy guns is much felt in England, and they are now in process of production. The action and the proposals of our American neighbours cannot fail to be of interest.

* See also "Questions of the Day, XVII., Heavy Ordnance for National Defence." By W. H. Jaques, Lieutenant U.S. Navy. New York and London. 1885.

PRIVATE BILL LEGISLATION.

The first few days of the resumed session have produced unusual activity in regard to private measures before Parliament, and also with respect to the general subject of private bill legislation. A considerable number of Bills has been read a first time, and in other ways put in readiness for progress; and an important debate has taken place upon a proposal to rearrange and reform the existing method of dealing with these measures. The usual report of the Board of Trade upon the various Bills presented for the session has likewise been issued, and this document officially confirms an observation we made some weeks ago, by stating that the Bills of the present session are not so important, either as regards the convenience afforded to the public or as regards the expenditure of capital, as those of last year and many previous sessions. Of railway, canal, tramway, and general Bills, there are 203 as against 227 last year, and the total amount proposed to be raised is only £54,527,189, or a decrease as against last session of £12,753,477. The Railway and Canal Bills number 132, of which 93 propose the construction of new works, while existing companies promote 97 schemes with the object of making 148 miles of line, for which purpose £15,661,026 must be raised. At the same time, there are 35 proposals by new companies for laying down nearly 400 miles—including one canal 35 miles long—for which the capital required is £28,726,963. Then there are 22 Tramway Bills projecting the construction of 122 miles, and the raising of £2,202,250. The eight Subway Bills lodged proposed works 12 miles only in length, but an expenditure of £4,150,000; while the 10 Gas Bills involve £620,000 new capital, and the 31 Water Bills £3,166,950. Besides these Bills there are 34 applications for Board of Trade provisional orders, one being for electric lighting, proposing to raise new capital to the extent of £754,574.

A first step with regard to Private Bills when once Parliament has met is the division of the work between the two Houses in regard to the initiation of the measures, so that both branches of the Legislature may make progress at the same time. The settlement of this point devolves upon the Chairman of Ways and Means—Sir Arthur Otway—and the Chairman of Committees in the House of Lords—the Earl of Redesdale, and they have decided that 84 of the total Bills shall originate in—that is, first come before—the House of Lords. Of these, 56 are English, 17 Scotch, and 11 Irish, and among the numbers are the Manchester Ship Canal Bill, the Albert Palace Association Bill, the Barry Dock and Railways Bill, the Columbia Market and Railways Bill, the Glasgow Corporation Water Bill—the Loch Katrine scheme, which we described last week—the Thames Deep Water Dock Bill, and the Southwark and Vauxhall Water Bill. Several Bills which have been postponed for various reasons upon the question of compliance with Standing Orders were passed during the week, but the Tower Floating Bridge Bill, the Crystal Palace, the South-Eastern and Metropolitan Railway Bill, the two Bexley Heath Railway Bills, the Duplex Tower Bridge Bill, and some of the tramway schemes are still in suspense. It is understood that the Charing-cross and Euston Railway Bill, the Ealing, Harrow, and Edgware-road Railway Bill, and the Brighton and South Coast Tramways Bill, will not proceed this session. The Islington and City, and the Marble Arch and City Subway Bills have been referred, with some others, to the Committee on Standing Orders. The numerous railway rates and tolls Bills are threatened with stout opposition from many quarters, and already petitions against them have been presented, while one hon. member has undertaken to move the rejection of at least half-a-dozen of them upon the motion for second reading. These have for the most part come from agricultural and trading bodies, and the Associated Chambers of Commerce have also resolved to oppose the Bills.

The Parliament-street Improvement Bill has been read a first time in the House of Commons, and in connection with this proposal it is worth while referring to a conversation that took place in the House of Lords on Tuesday. Lord Lamington, alluding to this measure, inquired whether the Government intended to give power to a private company to widen Parliament-street, and to carry out the other projected improvements in that locality. He urged the importance of the Government offices being concentrated as near the Houses of Parliament as possible, and protested against private persons being allowed to carry out in their own way such an undertaking as this, and to secure the best sites in the neighbourhood. The Earl of Rosebery explained that the Government had no intention to empower any private company in the manner suggested, and that as a matter of fact the Government had nothing to do with the Private Bill now before Parliament. He admitted that it might be desirable for Government to take up this matter, but he did not think that if public interests were properly protected the Government need offer any opposition to this scheme. To this the Earl of Redesdale retorted that the present proposal was most mischievous, and insisted that such a work as this ought to be undertaken by the Government. There the matter dropped, but the conversation imparts a new interest to the contemplated improvements at Westminster. Among the other Bills which have already passed their first stage in the Commons are these:—King's-cross, Charing-cross, and Waterloo Subway; Limehouse Subway—extension of time; Lower Thames Valley Main Sewerage; Regent's Caral, City, and Docks Railway; London and Blackwall Railway; London, Tilbury, and Southend Railway; Maidstone Water, Clapham and City Subway; Greenwich and Millwall Subway; East London Railway; Liverpool Improvement; Metropolitan Railway; London and North-Western Railway; Midland Railway—additional powers; North British Railway; Great Northern Railway—various powers; Metropolitan Board of Works—"to confer various powers on the Metropolitan Board of Works with respect to the making of a certain new street in the parishes of St. Andrew, Holborn, and of St. James and St. John, Clerkenwell; the establishing and regulating of ferries across the river Thames at Woolwich and Greenwich; the providing of recreation grounds for the public; the removal of bars and obstructions in the streets in the metropolis; and for other purposes;" Brighton and South Coast Railway—various powers; Hull, Barnsley, and West Riding Junction Railway and Dock; London and South-Western Railway—various powers; Channel Tunnel—experimental works—to authorise the South-Eastern Railway Company and the Submarine Continental Railway Company, either alone or jointly with other companies, to maintain and continue experimental works for a tunnel beneath the Straits of Dover, and for other purposes; Birmingham Electric Lighting; London Central Subway; Metropolitan Outer Circle Railway Bills.

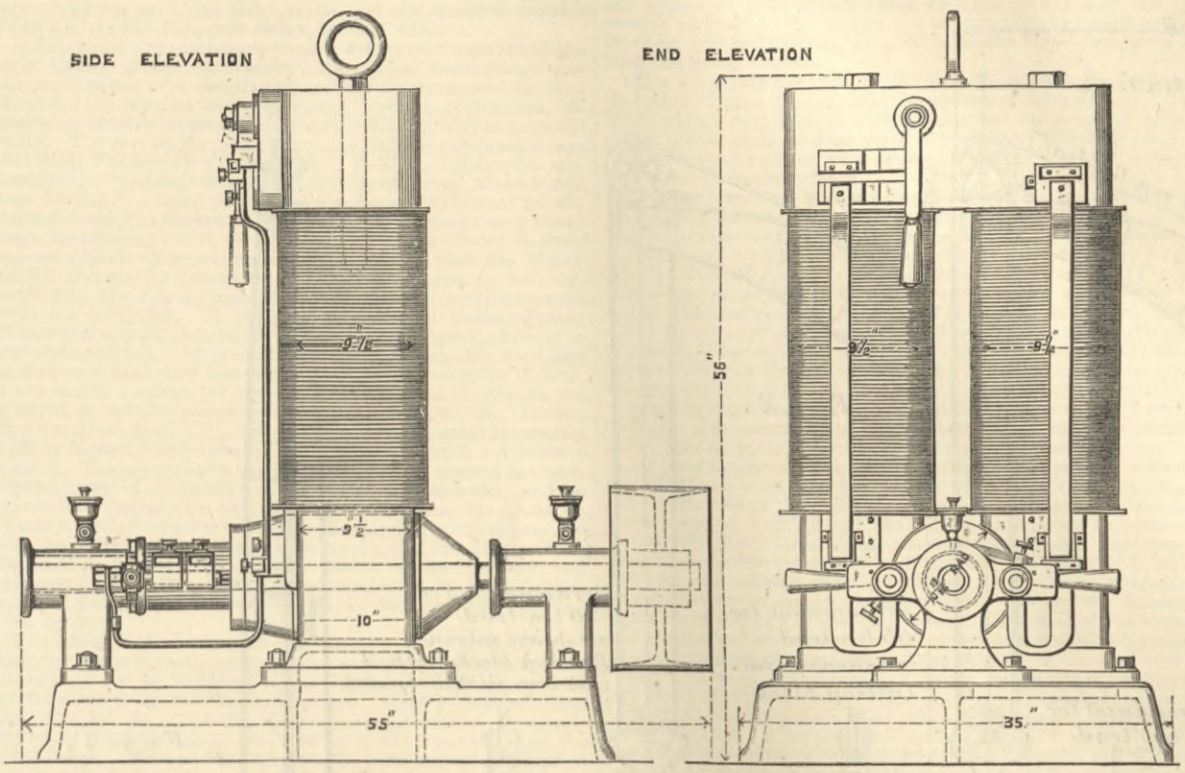
With respect to the Manchester Ship Canal Bill, an unusual, but very practical suggestion has been made, and is not unlikely to be adopted. Mr. Jacob Bright, one of the members for Manchester, reminded the House of Commons that the Bill of 1883 was passed by the Commons Committee, but rejected by the Lords, and that last year's Bill met with precisely the contrary fate, and raising the consideration whether the present session was likely to give sufficient time for two separate inquiries, he suggested that the best plan would be to send the Bill before a joint committee of the two Houses. Sir Arthur Otway, Chairman of Committees, pointed out that the Bill, having now been ordered to originate in the other House—as mentioned above—any proposal for a joint committee must also originate there. At the same time, he frankly confessed that he thought it would be wise, and in accordance with several precedents, to refer the measure to a joint committee, and if the suggestion were definitely advanced, he would gladly help to carry it out. So clear an opinion from an authority of such weight is not likely to be disregarded, and certainly the adoption of this course would greatly simplify the next effort to carry the Canal Bill through.

The debate to which we have referred arose in the House of Commons on Wednesday upon a Bill brought in by Mr. Craig Sellar to alter the present mode of dealing with Private Bills. After several hours' discussion, in which the Chancellor of the Exchequer advised that so large a project should be left to a new Parliament, while Sir Lyon Playfair, ex-Chairman of Committees, warmly supported the proposal, the Bill was rejected by a large majority. But the scheme is almost certain to be revived ere long, and it may just be worth while to mention that the Bill proposed to abolish the present system of a double inquiry upon every Bill—that is, by both Houses—and to delegate the execution and settlement of 'private schemes to three judges, to be called Judges of the High Court of Parliament, at a salary of £5000 a year each. They should be invested with all the powers necessary for a complete investigation, and should then be required to give the reasons for their decision to Parliament. They were further to have power to sit in any locality affected by a Bill under consideration, and generally to do all and more than what has hitherto been done by the Select Committees; while at the same time Bills would go through the preliminary stages in the same way as at present, and return to the House for third reading, so that Parliament would have final control over them. In support of his proposal, Mr. Craig Sellar cited several high authorities, and strengthened it by showing how the recent growth of parliamentary work had gone beyond the capacity of members. The debate was interesting, though the subject is by no means new, and was valuable in eliciting a very general opinion that before long something substantial must be done to facilitate private legislation.

DRINKING WATER FOR THE SOUDAN.

The large cable steamer Calabria, chartered by the Admiralty from the Telegraph Construction and Maintenance Company, has been fitted with what is considered to be the largest installation of condensing machinery ever put in one ship; it is for the purpose of converting the sea water at Suakim into drinking water for the troops and others employed in the expedition. This installation of condensing plant will include no less than ten distillers with filters attached, each distiller or condenser being capable of producing 6000 gallons of cold water every twenty-four hours, or a total of 64,000 gallons per day. For supplying the steam necessary for this, the two main boilers, which are about 1100 indicated horse-power, will be kept at work evaporating salt water, and an auxiliary boiler of about 200 indicated horse-power will be used for supplying steam for the circulating pumps. The pumps are three in number, each throwing 16,000 gallons per hour, two to be used, the third being in reserve, in case repairs are needed by either of the others. The condensers are of the Compactum type, invented by Mr. John Kirkaldy, of West India Dock-road, London, and illustrated in The Engineer 3rd July, 1883. The favourable opinion we then expressed has been confirmed by subsequent experience, over 400 having been sent out last year. The gold medal was awarded for them at the recent London International Exhibition. The machines are most simple in construction, and the fact that the whole of them on the Calabria occupy only a deck space of 21ft. by 18in., with ample room allowed to get to every part of them, the inclusive weight being 33 cwt., will give some idea of the compactness of the arrangement. The installation has been fitted up by the owners for the Admiralty, under the direction of the superintendent engineer, Mr. Crook, who has been assisted by Mr. Thompson, of the makers' firm, who was placed at Mr. Crook's disposal by the Admiralty. The time from receiving the condensers to the trial having been ten days, will show that Mr. Crook has lost no time in completing the work placed in his hands. The official trial and test took place on Monday afternoon, the machines being inspected for the Admiralty by Mr. Inglis, one of their engineers, and there was a large and distinguished company present to witness the production of the water and its passage into the enormous cable tanks, which will contain when filled 750 tons, and be supplemented by forty-eight additional 400 gallon tanks, so that 20,000 gallons can be at any time sent on shore in boats for use. The trial was most satisfactory, the surveyor expressing himself highly pleased with the result, which fulfilled all requirements; and attention was called to the dirt arresters, which are contrivances fitted for the purpose of preventing anything but pure steam entering the condensers; their efficiency was proved during the trial, as some red lead from the steam pipe joints did not enter the tube coils, as it would otherwise have done; a tray drawn out was cleaned and replaced; the joint, capable of sustaining a pressure of 200 lb. on the square inch, being made with a single nut, the removing, cleaning, and refixing being performed in less than a minute. Sir James Anderson, who, with Mr. Pender, Captain Halpin, Captain Peel, Mr. Crook, and others, was present, was so impressed with the results obtained that he directed Mr. Thompson to put in hand additional condensers for 10,000 gallons per day, and fit them in the steamship Magneta, which, like the Electra, also owned by the Eastern Telegraph Company, is already fitted with a 4000 gallon Compactum condenser.

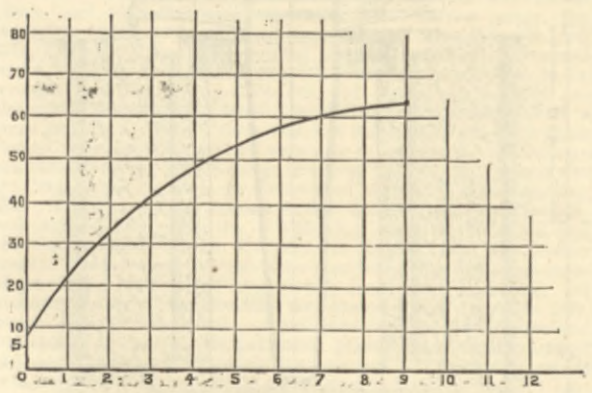
THE EDISON-HOPKINSON DYNAMO.



IN our issue of 23rd January we shortly described a test of an Edison-Hopkinson dynamo made at the works of Messrs. Mather and Platt, of Manchester. We now give full details of this specially interesting and severe test, along with drawings of the machine.

The dynamo subjected to test is designed for a load of 250 ampères, with 55 volts between the terminals, running at a speed of 900 revolutions per minute. This is equivalent to feeding 250 Swan lamps of 20-candle power. As seen below, during the test the speed varied from 920 to 927 revolutions, the current from 273 to 278, and the electro-motive force from 54·6 to 55·5, so that the test load was considerably in excess of the designed working load.

Fig. 1 shows a side and an end view of the machine with a section of the armature, and also the characteristic curve. The leading dimensions are marked on the drawing. The machine is compact; at least it occupies very little floor space for its power, its outside dimensions being 56in. by 36in. and 60in. high, and its weight 32 cwt. The magnet cores are of wrought iron 9½in. diameter. The magnet coils are 11in. outside diameter and 24in. long, there being the same thickness of wire wound on throughout the whole length. The commutator has 40 bars insulated by mica plates. It is 5½in. diameter and 5in. long. There are two brushes on each side, each made of round



wire laid in a pile about ⅝in. thick. The two pairs of brushes can be adjusted rotationally to minimise sparking independently of each other. After a three weeks' severe work they had worn less than ⅛in., and were showing no sparks at all, the commutator surface being perfectly smooth and ungrooved. This is effected by giving the shaft and all that it carries an oscillatory end motion. The collars are placed so as to give the desired amount of end play which is set up and maintained by the slightly irregular pull of the belt. The oscillation is regulated and steadied by a plate spring—not shown in the drawing—that presses on the end of the shaft with a force that can be regulated by a set screw. The commutator bearing is 8½in. long by 1¾in. diameter, and that at the pulley end 9in. long, the shaft being 2in. These are oiled by drop lubricators, and keep remarkably cool during the long continuous run. As seen from the day-to-day record given below, the temperature of the pulley bearing varied from 26 deg. to 37 deg. Cent., and that of the commutator bearing was usually about 2 deg. Cent. higher. These temperatures went up and down with the temperature of the air in the room, a conclusive proof that the bearings worked well, their temperature being generally 10 deg. Cent. higher than that of the air. Curiously enough, the lowest bearing temperature was taken on the last day of the run.

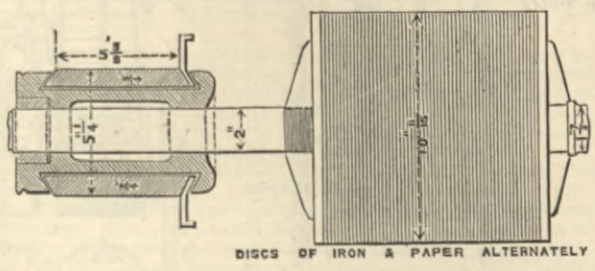
It is worth noticing that the pulley bearing was cooler than the other, in spite of its having a very much heavier pressure on it. This is due to the heating of the other bearing by conduction from the commutator, which of course rises to a much higher temperature in consequence of the rubbing of the brushes. The commutator temperature was from 70 deg. to 75 deg. Cent., while that of the brushes lay between 60 deg. and 70 deg. Cent. While we were present the lubrication was at the rate of forty drops of oil per minute to each journal.

The armature is what is called 10in. by 10in., its actual outside diameter being 10⅛in., and the pole pieces being bored to 10⅛in., thus leaving $\frac{1}{16}$in. side clearance. The armature core is built up of 28 b.w.g. iron plates insulated from each other by sheets of unprepared paper. There are 500 of these plates in the 10in. length, the 28 b.w.g. corresponding to ·014in. thickness. These plates, instead of being held by bolts piercing the plates from end to end, which method destroys good insulation, are clamped in place by two large stiff washers or loose collars on the shaft, one being screwed up on a screwed part of the shaft against the other. The shaft itself is well insulated from the plates. These plates are wound over with cotton-covered wire of about 16 b.w.g. to a depth of about ⅝in.

In a larger size of dynamo of the same type designed for 110 volts, to feed 500 Swan 20-candle power lamps, the magnets are of nearly rectangular sections, with large rounded corners, 11in. by 19½in., and 24in. long in the coiled part; the armature is 10in. diameter by 20in., and the commutator 5½in. diameter by 8in. long, with three brushes on each side and forty bars with mica insulation. The journals are 10½in. and 12in. long. Both of these have the magnets shunt wound, no advantage being found to accrue from compound winding owing to the low armature resistance. In the smaller machine used in the test, the magnet resistance is 7·54 ohms, and that of the armature is 0·009 ohm. The characteristic curve is given in Fig. 1, the horizontal scale giving the current through the magnets, and the vertical the electro-motive force between the terminals. It has been calculated by reducing to a speed of 900 revolutions per minute from the following measurements:—

Speed. Revs. per min.	E.M.F. Volts at terminals.	Current. Ampères through magnets.	E.M.F. reduced to 900 revs.
906	64·2	9·04	63·7
786	54·1	7·62	61·9
740	48·3	6·8	58·7
556	31·2	4·39	50·5

In the test, lamps were not employed as external resistance. For these were substituted boxes of strip iron with large surface,



giving free access to the atmosphere, so that the temperature and resistance kept nearly constant, this resistance being almost exactly 2 ohms.

From the measurements the following have been calculated:—

	Watts.	H.P.	Percentage.
Total electrical horse-power developed	16,250	21·78	100
,, loss in magnets	400	0·54	2·4
,, ,, armature	720	0·96	4·5
Useful power in external circuit	15,130	20·28	93·1

The mechanical horse-power delivered by the belt was also measured by a Siemens belt dynamometer. As between the belt horse-power and the total electrical horse-power, the efficiency was found to be about 93 per cent. As between the belt power and the useful electrical power, the efficiency would, therefore, be about 86 or 87 per cent.

Throughout the test a continuous indication of the electromotive force between terminals was given by a Thomson graded potential galvanometer, and the current was also read at intervals of one hour day and night by means of a Thomson graded current galvanometer. The bearing temperatures were taken by thermometers placed in mercury cups. The speed of the engine was continuously indicated by a tachometer, whose readings were checked from time to time by taking the dynamo speed by a revolution counter direct.

The first test was on December 30th, readings being taken at five, twelve, and twenty-four hours from the beginning of the run. The readings were:—

Temperature Cent.	Room.	Pulley bearing.	Commutator bearing.	Magnets.	Armature.	Commutator.
After 5 hours' run	17	35	36	33	76	70
After 12 hours' run	20	36	34	33	84	75
After 24 hours' run	15	30	29	33	76	74

The machine was then run continuously until January 6th, stopping only ten minutes each day to read the temperatures of the armature and commutator, and during Sunday. On January 6th the armature was taken out, examined by Mr. Blackburn, and found uninjured in any respect. The armature being replaced, a fourteen days' continuous run absolutely without break was commenced. At the end of this run the armature was still found uninjured in any way, either by swelling, charring, or breaking in the insulation of the plates. The conditions of this test were specified by Messrs. Albright and Blackburn for the Edison and Swan Company, and it was supervised and constantly watched by them and their representative, Mr. Creagh. Most of the readings were taken hourly. The following is a *résumé* of the record, consisting of the readings taken at the end of each day, and of the temperatures of armature and commutator at the end of the fourteen days' run. These latter were taken immediately on stopping, and again half an hour after stopping. They could not be taken, of course, during the run; and, of course, these temperatures could not be read for perhaps a couple of minutes after the instant of stopping. During this short lapse a certain amount of cooling, of course, took place, but seeing that the rate of cooling was only 9 deg. in the case of the armature and 6 deg. in that of the commutator in the course of half an hour, it is evident that the temperatures while running could not be more than a fraction of a degree above those recorded. During the last day of the test, however, the room was specially cool, and the bearings 10 deg. lower than their previous maximum. Therefore it is fair to infer that the armature temperature on, say, the 10th of January must have been nearly 100 deg. Cent.

Date.	Speed.	Ampères in external circuit.	Volts at terminals.	Temperature of room.	Temperature between magnets.	Temperature of bearings. Pulley.	Temperature of bearings. Commutator.
				deg. C.	deg. C.	deg. C.	deg. C.
January 6	920	273	55·5	20	55	31	32
,, 7	920	276	54·9	23	55	34	34
,, 8	925	273	54·9	23	55	32	32
,, 9	927	275	54·7	23	54	33	33
,, 10	926	278	54·9	23	56	37	35
,, 11	926	275	54·6	19	55	32	34
,, 12	921	276	54·6	20	53	30	32
,, 13	926	273	54·6	19	51	29	31
,, 14	921	275	54·6	18	52	28	32
,, 15	924	275	54·6	17	50	30	32
,, 16	925	276	54·6	23	53	32	32
,, 17	922	275	54·6	21	51	31	32
,, 18	922	275	54·6	21	50	29	31
,, 19	921	275	54·6	20	49	30	32
,, 20	923	275	54·6	18	50	26	31

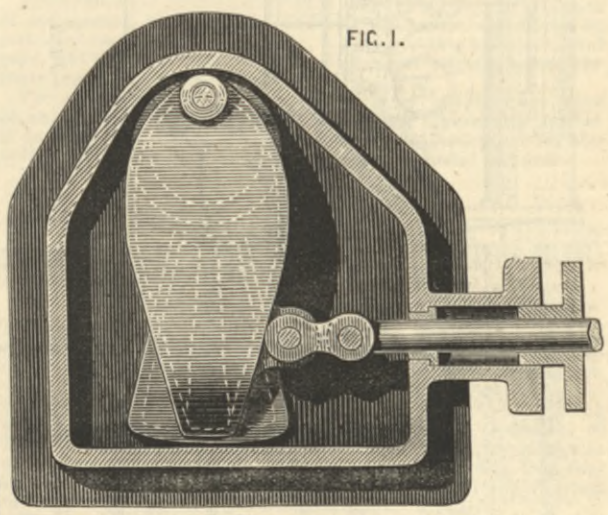
The final readings were:
Armature, at the end of the run, 90 deg.; commutator, 79 deg.
,, half an hour after stopping, 81 deg.; ,, 73 deg.

NOTE.—The temperature under the heading magnets is that of the thermometer hanging over the armature between the two magnet limbs, about 1in. from the coil.

PECK'S RELIEVED SLIDE VALVE.

IN illustration of our remarks in our leading article of February 6th on this subject, we publish to-day three views of a new relieved slide valve designed by Mr. Ed. C. Peck, of Old Charlton, having for its main object the reduction of friction, but possessing besides this other peculiarities. Mr. Peck's

FIG. 1.



proposal aims at the root of the evil, as instead of fighting it with any kind of complicated appliance, most of which, as we pointed out, are open to break down as well as increasing the moving weight; he avoids it by removing the exhaust opening out of the line of motion and allowing the valve to partly rotate on a pivot pin placed in a position nearly or quite coinciding with the centre of the exhaust orifice. This pin is placed preferably

FIG. 2.

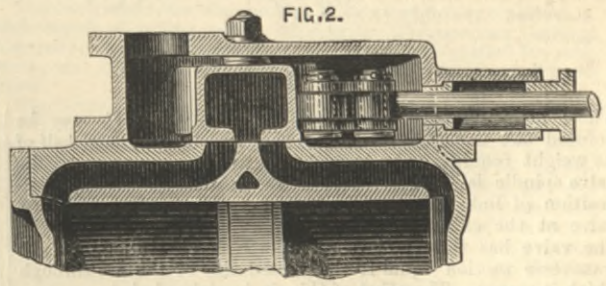
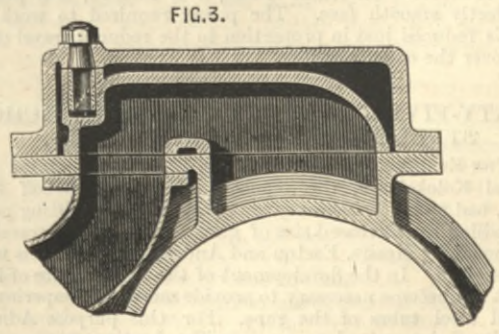


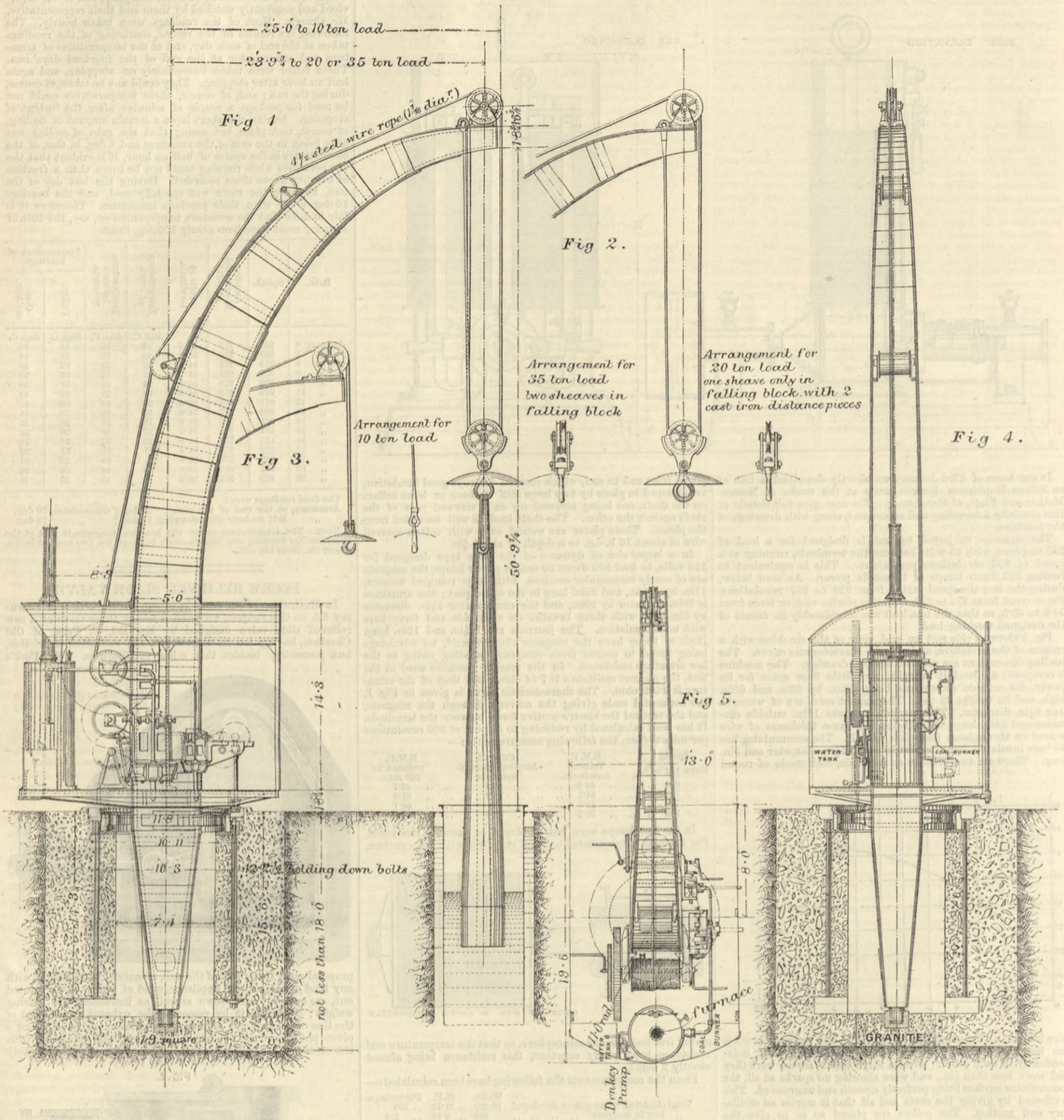
FIG. 3.



on the edge of the exhaust orifice furthest from the valve, so as to obtain the greatest leverage without increasing the small movement of this part of the valve.

The valve, as may be clearly seen, consists of a simple casting with one face, and the exhaust steam is removed from contact with the cylinder barrel, while the valve face is brought close up to the cylinder and the

35-TON STEAM CRANE, ABOUCHOFF STEEL WORKS, ST. PETERSBURG



whole cylinder casting considerably simplified. It may be pointed out that besides being a very light valve, only half of its weight requires to be moved. In another arrangement the valve spindle is jointed direct to the valve without the interposition of links and the pivot pin is removed, the end of the valve at the exhaust end being merely guided transversely. The valve has thus, besides its up-and-down motion, a slight transverse motion equal to the versed sine of the arc through which it moves. The effect of this, it is claimed, is to produce a perfectly smooth face. The power required to work this valve is reduced just in proportion to the reduced travel of the valve over the exhaust orifice.

THIRTY-FIVE TON STEAM CRANE, ABOUCHOFF STEEL WORKS, ST. PETERSBURG.

In The Engineer of 31st October, 1884, it was stated that Admiral Kolokoltzoff, the manager of the Abouchoff Steel Works, had found it necessary to provide increased lifting power for handling the increased size of guns, and a 150-ton travelling crane, made by Messrs. Easton and Anderson to meet this want, was described. In the development of the manufacture of large guns, it has become necessary to provide means of tempering the internal steel tubes of the guns. For this purpose Admiral Kolokoltzoff determined to arrange the heating furnaces and oil annealing tanks round a revolving steam jib crane, which would command them all. Messrs. Easton and Anderson designed and made this crane, which is illustrated by Figs. 1, 2, 3, 4, and 5, Fig. 1 being a side elevation, with double sheave falling block for 35-ton lift. Fig. 2 shows the single sheave falling block for 20-ton lift. Fig. 3 shows the hook at the end of the wire rope without a falling block for 10-ton lift. Fig. 4 is a front elevation, and Fig. 5 a plan of the crane. The crane is of the ordinary tubular form, constructed of iron plates and angles, with a radius of sweep of 23ft. 9¾in. to the centre of the hook of the falling block and 25ft. to the centre of the hook when no falling block is used. The height of the underside of the jib head above the ground is 50ft. 9in., and the clear lift above the ground with the falling block in use is 44ft. The toe of the crane is made of cast steel, and rests on a hardened steel disc dropped into a cast iron step which is let into a large block of granite embedded in the concrete foundation, as shown in Fig. 1. At the ground level a cast iron circular roller path is built into the foundation, and a corresponding one encircles the crane post; a ring of live rollers being placed between the two. An iron platform is built round the post to carry the boiler, coal bunker, and feed-water tank, and the attendatns. This platform is open all round, but covered with an iron roof to protect the attendants from the hot oil which is apt to be thrown up out of the tank when the hot tube is lowered into it. The hoisting gear is arranged on the back of the post, and the circling gear in front of it, whilst the engines are fixed to one side of the post. There is one pair of engines for hoisting and lowering, and a separate pair for circling. Each pair transmits its power by bevel gear from the crank shaft, and is made to reverse by means of a reversing slide valve, changing the steam and exhaust. The circling engines communicate motion to a vertical shaft carrying a spur-pinion at its lower end, which gears into a spur ring bolted to the fixed roller path casting. Hand gear is also provided in case of need. The hoisting gear consists of two pair of tooth wheels only—pair of bevel wheels from the crank shaft to first motion sha and a pair of spurs from this to the barrel shaft. Hand gear provided in case of need. A brake is fitted to the intermediat shaft, with a handle to work it suitably placed on the platform The load is lifted by one of Bullivant's patent flexible 4½in steel wire ropes, 265ft. long. For the full load of 35 tons double sheave falling block is used, with four parts of rope t carry the load, as shown in Fig. 1. When less power is require one of the sheaves is removed from the falling block, and the load is carried by two parts of the rope only, as shown in Fig. 2. This is called the 20-ton purchase. Finally, the falling block may be removed altogether, as shown in Fig. 3, and a single part of the rope only used for what is called the 10-ton purchase. It will not be necessary to change from one purchase to another often, nor at short notice; hence this arrangement has been adopted by preference, and the gearing left as simple as possible, which is an advantage at the quick speeds the crane is made for. The steel tube, which is to be tempered, is lowered into a suitable furnace. When sufficiently heated it is lifted quickly out of this furnace; the crane is turned a little, to plumb the neighbouring oil tank; and the tube is then lowered as quickly as possible into the oil. In hoisting the engines make 100 revolutions per minute, and the speed of the single rope for the 10-ton hoist is 44ft. per minute. The 20-ton hoist is therefore performed at 22ft., and the 35-ton hoist at 11ft. per minute. The lowering is effected by the engines, which can be allowed to run at 250 revolutions per minute; and the speed of lowering for the three powers would then be 110ft., 55ft., and 27½ft. per minute respectively.

THE INSTITUTION OF CIVIL ENGINEERS.

THE METROPOLITAN AND METROPOLITAN DISTRICT RAILWAYS.

AT the ordinary meeting on Tuesday, the 17th of February, Sir Frederick J. Bramwell, F.R.S., President, in the chair, the first paper read was on "The Metropolitan and Metropolitan District Railways," by Mr. Benjamin Baker, M. Inst. C.E.

In this paper the author commenced with a brief account of the early history of the undertaking, its gradual development and like matters not of a strictly engineering character, and he then proceeded to consider the engineering features of the line, its gradients, tunnels, sewer-crossings and other ordinary and special works. The first length of Metropolitan Railway constructed was that from Paddington to the City. In 1814, Paddington was described as "a village situated on the Edgware-road, about a mile from London." Forty years later the Act of Parliament for the railway from Paddington to the City was obtained, and thirty years then elapsed before the whole of the "Inner Circle" Railway was completed. The original intention was to work the Metropolitan Railway by hot-water locomotives, burning no fuel and condensing the steam; consequently no special provisions were made for ventilation. It was also thought that trains weighing 20 tons inclusive of passengers would be the heaviest that could be usefully employed. At present the trains weighed 120 tons, and as they were hauled by coal-burning locomotives weighing 45 tons, it was hardly a matter for surprise that additional ventilation was required on certain portions of the line. In 1860, Mr. Fowler, Past-President Inst. C.E., had a special experimental locomotive built by Messrs. Stephenson of Newcastle, but it did not prove a success. The engine had a small fire-box, a large mass of fire-brick stowed away in a chamber in the barrel of the boiler, and an injection condenser with air pump. When the line was opened in January, 1863, it was worked by coke-burning locomotives provided with condensers. The engines were six-wheeled broad-gauge tank locomotives, having four coupled wheels 6ft. in diameter, and cylinders 16in. by 24in. The present engines were eight-wheeled, and had four coupled wheels 5ft. 9in. in diameter, and cylinders 18in. by 24in.

The contour of the ground traversed by the "Inner Circle" Railway was not easily recognisable, owing to the surface being densely covered by buildings of varying heights, and the natural watercourses being converted into sewers. In early historical times the little hill on which the City stood was fronted by a wide stretch of tidal marshland, and flanked by the Fleet river and the Wall brook. West of Westminster the river extended inland at least a mile, forming the swamps of St. James's Park, Pimlico and Fulham. To the north extended the rising ground culminating in the heights of Hampstead and Highgate, and the lesser heights of Campden Hill, Primrose Hill and others. The highest ground traversed by the railway was at Edgware-road, and the lowest near Victoria-street, Westminster, the respective heights being 103ft. and 8ft. above ordnance datum. Between the spurs of the northern heights ran the West Bourne, the Ty-Bourne and other minor streams now converted into sewers, which crossed the railway at Baker-street, Warwick-road, Sloane-square, King's-cross and other points, in iron tubes ranging in size up to 14ft. by 11ft. The physical features of the ground, and not the presence of buildings, determined the gradients. On the south the rail level was 13ft. below Thames high water, on the north 60ft. above it, and, as the ground dipped from north to south at a steeper slope than was admissible on a railway, deep cuttings and tunnels were necessitated on the eastern and western portions of the circle, and gradients of 1 in 70 and 1 in 100 had to be introduced. As regarded the character of the ground cut through, about 24ft. of ruins and dust were met with in the City and at Westminster, about 50ft. of mud and silt at Charing-cross, and layers of peat were found at varying depths in the swampy ground of Westminster. The characteristic section, however, was a river drift deposit of gravel, sand and brick-earth overlying the London clay, which deposit was found alike in Westminster at a level of 8ft., and in Marylebone at 103ft., above ordnance datum. The remains of animals swept down by floods indicated that the gravel must have been deposited at a time when the mammoth, rhinoceros, and hippopotamus roamed about the valley of the Thames.

The first 4½ miles of Metropolitan Railway were laid with mixed gauge, and the remaining 8½ miles with narrow gauge, the respective widths of tunnels and open cuttings being 28ft. 6in. and 25ft. Where a junction occurred between two lines in covered way a "bellmouth" was constructed; that at Praed-street had a wrought iron elliptical top 28ft. 6in. wide at one end, and 60ft. at the other, the structure much resembling the inverted hull of a large iron ship. Where there was not sufficient depth for a brick covered way, cast iron girders were as a rule adopted. At average contract prices the 25ft. brick covered way in 25ft. cutting cost £39 per lineal yard, and the girder covered way in 17ft. 6in. cutting £52. There were three tunnels on the "Inner Circle," the Clerkenwell tunnel, 728 yards, the "Widening" tunnel, 733 yards, and the Campden-hill tunnel, 421 yards in length. The two former were in London clay, and the latter was driven through a wet mass of gravel and sand extending generally down to the springing. At average contract prices the 28ft. 6in. tunnel cost £70 and the 25ft. tunnel £63 per lineal yard. A settlement of the ground over and contiguous to the tunnels had taken place in most instances, and the causes of this were carefully investigated. In the open cuttings retaining walls of brickwork and concrete, with or without cast iron struts, were adopted. Without struts the cost in 25ft. cutting was £66, and with struts £55 per lineal yard. Where the depth was 42ft. two rows of struts were employed, and the cost was £108 per lineal yard. In executing the works, the character of the timbering varied from time to time under different contractors; but finally the general practice was to build the walls in trenches, and remove the dumpling afterwards, the timbering being much lighter than when the excavation was carried out full width.

There were twenty-seven stations on the thirteen miles of "Inner Circle" Railway. The Baker-street, Portland-road, and Gower-street Stations were covered by segmental brick arches of 45ft. span, and the Temple Station, Mansion House Station, and some others, were more or less underground. Wherever practicable, "daylight" stations with light elliptical iron roofs were adopted. Many special works occurred on the line. Sewer diversions, gas and water mains, maintenance of road traffic and the support of buildings, presented problems of great novelty. At Park-crescent, where the line passed under two houses, the latter were pulled down and rebuilt on iron girders; but at Pembridge-square the girders were introduced without taking down the houses. At Farringdon-street underpinning works of great magnitude and difficulty were executed, and along the line many cases of successful underpinning occurred. Since the completion of the works, buildings up to 80ft. in height had been erected over the railway, sometimes on girders and sometimes on brick arches, and no difficulty had arisen from vibration.

The paper was accompanied by diagrams illustrating the ordinary and special works on the 11¼ miles of "Inner Circle" Railway, with the construction of which the author was personally connected, his partner, Mr. Fowler, having been the engineer-in-chief.

THE CITY LINES AND EXTENSIONS (INNER CIRCLE COMPLETION) OF THE METROPOLITAN AND DISTRICT RAILWAYS.

The second paper read was on "The City Lines and Extensions (Inner Circle Completion) of the Metropolitan and District Railways," by Mr. John Wolfe Barry, M. Inst. C.E.

It was observed that the completion of the circle had always been kept in view by both the Metropolitan and the District Companies, and Parliment was at all times in favour of the undertaking. After many failures to realise the project, the two companies in 1878 agreed to refer the mode of completing the "Inner Circle" to Sir John Hawkshaw. He recommended the extension of the railway southward from Aldgate to Tower Hill, and thence westward along Great Tower-street, Eastcheap and Cannon-street to join the District Company's railway at Mansion House, and that the Corporation and the Metropolitan Board of Works should be invited to join with the two companies in widening Eastcheap and Great Tower-street, and in the construction of a new street between Mark-lane and Trinity-square. The author was appointed joint engineer with Sir John Hawkshaw. An important addition to the project was an extension eastward to join the East London Railway, so as to serve the large population of East and South London.

After describing the route of the line, the author observed that the term "Inner Circle" was somewhat of a misnomer. The Metropolitan and District railways formed an irregular ellipse rather than a circle, and the eastern portion of the ellipse was so flat, that the two lines were approximately parallel and near to each other for some distance.

The Parliamentary estimate was, for the railway and land, £2,365,261; for street widenings and a new street, £929,412. After lengthy negotiations, it was agreed that the Metropolitan Board of Works should contribute £500,000, and the Commissioners of City Sewers £300,000, towards the undertaking. The works were commenced in August, 1882, and were completed and opened for traffic—together with the Whitechapel extension—in October, 1884.

The location and setting out of a railway amid such a collection of streets, churches, railway stations, warehouses, shops and offices, between Mansion House Station and the Tower of London, involved anxious consideration. It was often a question of a few inches whether an important and expensive building could or could not be avoided. The course of the railway being approximately parallel to the Thames, many important sewers were of necessity intersected. In all cases the sewers had been carried under the railway without resorting to inverted syphons; but there had been important alterations of the sewers themselves. It was also necessary to construct a new sewer on both sides of the railway throughout its course in Cannon-street and Great Tower-street, and a portion of Eastcheap. The old sewer down the middle of the road was removed to leave room for the railway, but it had to be kept in use, or temporary troughs had to be employed, until the new sewers were finished. Upwards of 300 new connections between the drains of the houses and the sewers had to be made. These sewer works added greatly to the difficulties of carrying out the railway.

The sections of the covered way, which was partly of brick arch and partly of girder work, were then described. The holes excavated beneath the foundations of buildings for underpinning were usually about 4ft. long. After the holes had been carried to a good foundation, they were filled with Portland cement concrete, and allowed to stand for thirty-six hours. The top portion of the underpinning was executed in brickwork in Portland cement. With a single exception there was no settlement or damage to any of the underpinned buildings. One work of underpinning was the granite statue of King William IV., supported upon a granite pillar finely jointed, and resting upon a foundation of lime concrete. A work of some interest was the carrying the railway beneath the warehouses on the south side of Great St. Thomas Apostle and Cloak-lane without pulling them down. This was accomplished by gradually inserting portions of the side walls, turning the arch of the tunnel intermediate between the party walls, and finally by uniting the lengths of arch through the party walls. Another difficult work was the carrying of the railway beneath the old viaduct of the Blackwall Railway. The foundations of the old viaduct were removed and underpinning was substituted, without disturbing the structure or interfering with the traffic of the Great Eastern and Tilbury and Southend railways.

An important part of the work of constructing a railway through the heart of the City of London was the temporary works for keeping the street traffic open. The first operation was to lay down at night, over such a length of street as could be safely undertaken with a certainty of the operations being finished before 6 o'clock in the morning, the cross timbers running from one side of the street. These were 12in. by 12in., and placed 4ft. apart, from centre to centre. Upon them were laid 4in. planks longitudinally with the roadway, and on the top of these 3in. planks at right angles to the roadway. The next operation was to drive the main-heading, and from it cross-headings, by which to approach the backs of the cellar-walls of the houses. These walls were then broken through, and access was thus obtained to the foundations of the front walls of the buildings without disturbance of the roadway or foot-pavement. Where there were no cellars the headings were continued up to the front walls, and a side heading was driven parallel to the houses. From the side-heading, or else through the cellars, underpinning holes were then sunk beneath the foundations, and the concrete and brickwork were placed in position. When the underpinning was completed, the main trenches for the side walls and the sewer were undertaken. The arch was then turned and the backing put in.

The stations between Mansion House and Aldgate were three in number, Cannon-street, Monument, and Mark-lane. Cannon-street Station had to be constructed partly under Dowgate Hill, where there was only 1ft. of available height between the top of the railway and the road, partly under the forecourt of Cannon-street Station, and partly under Cannon-street. The booking-office had to be accommodated between the top of the railway construction and the surface of the forecourt, and provision had to be made for interchange of traffic with the South-Eastern Company's Cannon-street terminus. Thus, under the forecourt there were three tiers of traffic: (1) the trains, (2) the passengers using the booking-offices, and (3) the cabs and carriages in the forecourt. The total height from the level of the rails to the surface of the forecourt was 25ft. 6in. Monument Station was constructed on the site of the old Weigh-house Chapel, and had more area open to the sky than the other stations. The northern side wall of the station was so far north of the southern face of Eastcheap that much intricate girder work was required, more especially as it was necessary to provide for carrying a row of buildings on the south side of Eastcheap. Mark-lane Station was constructed wholly beneath the new street and was covered by girders in one span of 52ft., the jack arches in this case being at right angles to the line of the railway. The minimum length of the platforms at all the stations was 300ft. and the minimum width of each platform was 16ft. The width of the stairs was generally about 8ft., and the stairs and lobbies were in all cases recessed so as not to encroach on the minimum width of the platforms.

The Act of Parliament gave the companies the right to construct ventilators in the roads and open spaces, such as those known as blow-holes, but when the works were being undertaken the agitation against the blow-holes was at its height, and Parliament had gone so far as to take away from the District Company the right to retain some of the blow-holes which it had in a previous session authorised them to construct. It was therefore decided to adopt the alternative which had been pressed upon the District Company by the public authorities, and to put up fans to exhaust the foul air from the tunnel by machinery. Accordingly, fans had been erected, one in Cannon-street, midway between Cannon-street and Monument stations, another midway between Monument and Mark-lane, and one in the Whitechapel-road. The fans had no sooner been set to work than complaints were made that they occasioned vibration, and an injunction to restrain the companies from using them was granted,

In the case of the blow-holes the power was provided by the induced current due to the passage of the trains, and thus each hole acted as a lung, working rateably with the number of trains travelling on and fouling the railway. Thus the same agency which fouled the air of a tunnel by the passage of an engine supplied the power of purifying the air.

The cost of the works had amounted to about £20,000 less than the Parliamentary estimate, and the land was also less than had been estimated. No serious accident occurred in carrying through the enterprise. The works were prosecuted with great energy and fertility of resource by the contractor, the average number of men employed at times being about 850 by day and 500 by night.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, February 13th.

THE securing of an export trade is furnishing the manufacturing and commercial interests of the States food for thought and discussion, and some of the recent indications express a change in sentiment in the direction of freer commercial relations. The revenue reformers are preparing for an active campaign during the coming four years, with the view of electing a Congress in favour of lower duties. An organisation has been effected in this city and Brooklyn, ably managed and supported, and vigorous work is to be prosecuted throughout the country by the expenditure of money in educational pamphlets. The protective element has also recently organised for the purpose of pushing Protection doctrines in the West and South. This association had its origin in Eastern Pennsylvania, among the iron makers. The organisation is to be known as a National Protective Tariff League. The manufacturers and all those favourable to Protection have been urged to support this movement. Attention has been called to the dangers which threaten the industry from the efforts of the revenue reformers, and appeals are made to the selfish interests of American manufacturing interests with a view to raising a large fund to prosecute an educational campaign in educational districts. An executive committee has been created, which will supervise the practical efforts of the organisation; branch leagues are to be formed, lecturers maintained, and small publications distributed. This unusual interest is due to a change of sentiment among the voters as to the value of the protective system. Wage workers are more discontented than ever. The sweeping reduction of wages in so many branches of trade during the past year has created doubt in their minds as to the value of high duties, and their doubts are to be taken advantage of by the revenue reformers.

The production and consumption of iron during the past year shows a 10 to 12 per cent. decline over that of 1883. The iron trade has re-arranged itself, and the competition from southern sections promises to be much more active.

The shipping question is receiving closer attention. A few ship-building establishments are doing little more than building small vessels for coastwise and lake service.

The direction of all import taxes, excepting those necessary for the support of the Government, is being urged as the only sound policy to secure the shipping vessels which, it is recognised, are needed for the development of an export trade. Congress will do nothing for the shipping interests this winter. The expected increase in the consumption of iron and steel has been disappointing. A further restriction in production is probable, unless some new and unexpected demand should arise.

The reorganisation of the Reading Company is still checked by the adverse opinions of the holders of different classes of securities. The proposition has been made that the Reading Company should discontinue the mining of coal on its own account, and lease its collieries on royalties. It is estimated that the former policy has resulted in the loss of 6,000,000 dols. during the past six years, while by a wise royalty system a profit of 5,000,000 dols. would have been realised during this period. The general mortgage bond interest will make no further concessions unless the policy of the new managers is made to conform to their suggestion. They say that its present financial condition cannot but end disastrously unless a radical change takes place at an early day. A plan has been submitted, embodying a number of important changes, by which the holders of the older securities will be paid first and the holders of the junior securities last. The property would have to bring 67,000,000 dols. in order to meet its obligation.

The question of railroad discrimination is occupying the attention of commercial circles. The railroad companies are driven by restricted traffic to establish rates, which is working to no industrial good, and this is giving rise to an organised attempt before the State Legislature to secure relief.

The coal trade is in an unsettled condition, but there are signs of an improved demand, which the company thinks will enable it to dispose of the agreed upon 31,000,000 production in the anthracite regions at better prices than were realised last year.

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

(*From our own Correspondent.*)

THE necessities of the Soudan Expedition, especially as arising out of the Suakim-Berber Railway, are bringing a good share of heavy work to the South Staffordshire and Birmingham district. Wherever orders have been booked the operatives are this week engaged day and night in executing them, dispatch being needed with all possible urgency. The Horsley Company, of Tipton, have in hand for Messrs. Lucas and Aird, the contractors of the line, a pier composed of wrought iron solid piles, with cast iron screws, and cast iron caps, together with all the diagonal bracing to complete one hundred 15ft. bays.

The total weight is between 100 and 150 tons, and with the exception of some of the pins the whole will be of wrought iron. By the end of next week the company will have completed and despatched the work, so that no more than a fortnight will have elapsed between the receipt of the order and its execution. The company has good expectations of the early receipt of other considerable quantities of pier and engineering work in connection with the line, and is fully prepared to meet any special conditions of an engineering sort that may turn up.

The contractors are also coming to this district for a portion of their supply of rolling stock. Already the Metropolitan Carriage Company, Saltney, Birmingham, has received a contract for such work, and other rolling stock orders are also understood to be about.

The heavy wrought iron tube makers have been laid under contribution, and the work comes at a very opportune time, since general orders are very short. It is understood here that it is the intention to convey water from Suakim along the line for the first fifty or seventy miles, in 3½in. or 4in. pipes, but whether this distance will be subsequently increased is not believed to have been definitely determined upon. Messrs. John Russell and Co., Alma Works, Walsall; Messrs. James Russell and Sons, of the Crown Tube Works, Wednesbury; and Mr. Joseph Aird, of the Wellington Tube Works, Great Bridge, have all accepted contracts, and are executing the work with much speed. It is thought that if present orders can be despatched quickly, others will be then received. Messrs. James Russell's present order is for five miles of the pipe line.

Messrs. Jno. Russell, in May last year, conducted several experiments for the Government at Aldershot to prove to them the practicability of a pipe line, when the question of the Suakim-Berber route was first under consideration. The experiments proved highly successful, but at that time the Nile route was adopted. These experiments were conducted with 2½ miles of pipe, 3½in. bore, and they were screwed together by parties of engineers and infantry soldiers under the superintendence of Messrs. Russell's staff. When the new expedition was decided on and the Government determined to lay a pipe line, the work of manufacturing the tubes was offered to Messrs. Jno. Russell, and they have accepted as considerable a portion as their other engagements will allow of their executing in the required time.

Messrs. John Lysaght and Sons, galvanisers and sheet iron makers, of Wolverhampton and Bristol, have this week taken a big contract from the army authorities for galvanised iron corrugated houses for hospital purposes, and this is causing additional activity at the firm's extensive ironworks in Wolverhampton.

The total number of light tanks, of eight to ten gallon sizes, for water conveyance by camel transport, which, as I last week intimated, the authorities have ordered, is understood to be some-

where about 10,000, and to ensure rapid delivery the work is being placed not here alone, but in various parts of the kingdom. Entrenching tools continue to be forwarded to Woolwich, and large quantities of boats' ironwork for transport purposes is being demanded from the shipping tackle makers. In the case of some firms no limit has been placed upon the quantity to be supplied, and there has not been so much activity in this branch on Government account for several years past.

The advent of this work into the district is having a beneficial influence upon the iron trade proper. Not only is the demand improved at the moment in some directions, but a feeling of somewhat more confidence in the future is excited. Another feature which ministers this week to a more hopeful view is the information concerning the prediction by the Council of the American Iron and Steel Association of "a revival of a surprising nature in these departments of industry." Some importance is attached to this news by iron and steel masters here.

To-day—Thursday—in Birmingham members of 'Change who were through the iron districts of the United States during November and December spoke of the prophecy as not unlikely to prove correct, since their own observations have led them to the opinion that this year would see a revival in the States trade. It is needless to add that experience has shown that better trade in the United States means also a better trade in the iron and steel industry of this conntry.

There was information on 'Change that already, through London merchants, American buying is showing increased vigour in the direction of obtaining steel wire rods and steel fencing rods, and other light descriptions of steel, from the German works, mainly to be used up in the States, largely for screw making, barb wire fence manufacture, and so on.

Merchant inquiries on account of several of the European markets are rather favourable, good consignments of iron being needed for the South of Russia, Italy, and Spain; but an alteration in the northern markets is not hoped for until the ice-bound ports are open again.

The demand for sheets still leads the market, though even in this branch the works are by no means fully on. The galvanisers are, with few exceptions, buying sparingly, since the orders which they are receiving from Australia, South America, and India are by no means up to the average. Specifications, too, under old orders still linger. Merchant orders are being received with some briskness from London, Liverpool, and other centres.

Prices do not improve in any direction. Common merchant singles may be had as low as £6 15s. delivered London, and galvanising singles at £7 5s. delivered London; doubles are £7 15s. and lattens £8 15s. in the Thames. Tank plates of ordinary quality, £6 10s. at works, and better qualities are £7. Boiler plates of guaranteed quality are £7 15s. Marked bars remain at £8 2s. 6d. to £7 10s., and ordinary bars £6.

Representatives of Welsh steelmasters and hematite pig firms continue to push business in this centre. Blaenavon Bessemer tin bars are coming into this district at £5 10s. per ton, all ready for rolling down; and Dowlais steel plates for boiler making at £8 per ton. Blaenavon hematites are quoted at 55s. delivered, and on account of their purity are securing a good sale. Some other hematites are changing hands at 52s. 6d. per ton.

The pig iron trade does not rally in the forge department, but foundry pigs are going off pretty well. Prices are unaltered on the week.

The agitation against the excessive railway rates is leading to the inland waterways being more than previously utilised in this district. Considerable contracts of iron, in the form of sheets &c., are being now sent to London by canal at a cost of only 12s. 6d. per ton, as against the 15s. charged by the railway companies. And traders believe that there is a possibility of the water rate being reduced to 11s. 3d. One carrier has just contracted to deliver 2000 tons of sheets to London in this manner.

This week the properties of the Chillington Iron Company, Wolverhampton, are offered for sale by private contract. The Chillington Works comprise two forges, five sheet and plate mills, two hoop and guide mills, fitting shops and foundry, boiler works, &c. The Caffonfield plant embraces sixteen puddling and ball furnaces, three sheet mills, and hoop and guide mills. The Leabrook Works, Wednesbury, comprise twenty ball and puddling furnaces, and two sheet mills.

Constructive engineers keep active upon bridge and girder work, upon gasometer construction, and the like. The Patent Shaft and Axletree Company, Wednesbury, has just despatched the last span of the big bridge of the Afghan Frontier Railway, and the contract, which has consumed over 4000 tons of ironwork, is now completed. Among the orders just begun upon at the works may by mentioned a considerable order for iron bridges for Japan, and some small bridges of steel on account of Indian railways. The Horsely Engineering Companys has in hand seven 150ft. span bridges of iron and steel for the South Indian Railway, ten 70ft. span bridges wholly of steel for the Great India Peninsula Railway, and piles, girders, and general bridge ironwork for the Bombay and Baroda Railway. Its home contracts include the Charing-cross railway bridge, booked a while ago, which will consume some 6000 tons of iron and steel. The six main girders are each of 170ft. span, and will be of steel, while the remaining girders will be of iron. The company has likewise the iron bridge to be thrown across the Medway at Rochester by the South-Eastern Railway Company, and which will take 3000 tons of iron. Ironwork for gasworks' erections at Copenhagen is likewise being turned out at this company's establishment.

Ironfounders hope for an increase of work, as the outcome of the requirements of the Sanitary Authorities at Kidderminster for 340 tons of 15in. and 9in. cast iron socket pipes for the commencement of their new waterworks scheme. An attempt will likewise be made to secure for this district the supply of 100 cast iron lamp pillars needed by the Swansea Corporation.

No time is being lost by traders in the Midlands in formulating strenuous opposition to the Railway Rates and Charges Bills. To-day—Friday—there will be another meeting in Birmingham, presided over by the Mayor, at the instance of a numerous and influential body of manufacturers and traders, who consider that they are not sufficiently represented by the two associations already in the district for opposing the Bills. The object of to-day's meeting is to form a strong local committee to oppose the Bills. At Wolverhampton the Mayor, in response to an influential requisition, has decided to call a meeting on the 4th prox., at which steps will be taken to attempt to defeat the object of the railway companies. The Town Councils of Hanley and Worcester have also signed petitions against the Bills.

For the first time since the Sandwell Colliery Company began trading it is unable to declare a dividend. The chairman attributes the loss sustained during the past half-year to the prolonged strike of colliers.

The agitation in the nut and bolt trade has so far progressed that the workmen have come out on strike against nearly all the masters hereabouts who refuse to join the Employers' Association. The Executive Council of the men's society have been empowered to continue their efforts until all the men are called out or the object in view is attained. The men boast that they expect that they will have attained their object in about a month hence.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Before The Engineer reaches its readers the combined Coalowners' Associations of South and West Yorkshire—combined for this purpose only—will have decided to ask from the miners a return of the 10 per cent. advance granted in the end of 1882. There is no doubt whatever that this course will be taken, and there seems equally little doubt that the reduction will be resisted. During the busy times of 1871-2-3 wages went up by "leaps and bounds" 57½ per cent. As "they went up like a rocket they came down like a stick." In 1874 and 1875 no less than 30 per cent. was knocked off, and the men argue that the whole 57½ per cent. has now gone. The employers say that there still remains the 10 per cent., which they mean to take, as the state of the coal trade does not warrant, they say, the existing rate of remuneration.

There has been some movement in the steel rail trade since my last. Messrs. Lucas and Aird, the contractors, have given out 4000 tons of the 25,000 tons they require for the construction of the railway from Suakim to Berber—a distance of 270 miles. It is understood that 2000 tons have been placed with Messrs. Charles Cammell and Co., and 2000 tons with the Barrow Company. Messrs. Steel, Peech, and Tozer, of the Phœnix Bessemer Works, have booked an order for 1700 tons of rails for the Egyptian railways. The rails are a heavy section—72 lb. to the yard—and double-headed. They are intended for Alexandria. The rails for the Soudan are colonial section — flat-bottomed, and spiked to sleepers, the ordinary chairs being dispensed with. They are only 56 lb. to the yard, but this weight, though light as compared with what is usually laid on English railways, is heavier than is required for a temporary transport line, and shows that the railway is intended to be of a permanent character.

I have already intimated to you that the leading Sheffield firms who make the production of heavy ordnance a special branch of manufacture, had determined on a heavy expenditure to increase their facilities for turning out heavy ingots. This enterprise is all the more remarkable, as up to the present the Sheffield firms, with their existing plant and machinery, have been able to do everything that has been required of them. On Friday I had the opportunity of seeing what Messrs. Vickers, Sons, and Co. are doing. They have nearly completed a most powerful forging press, with a crane capable of lifting 150 tons. Mr. Vickers, the able chairman of the company, states that there are undoubted advantages in using the press instead of the hammer when large masses of steel are being manipulated. Messrs. Charles Cammell and Co. are erecting a special building at Grimesthorpe Steel Works to contain an immense forging press, which will have a power of between 4000 and 5000 tons, and be served with two cranes each capable of lifting 150 tons. Messrs. Thomas Firth and Sons, Norfolk Works, and Messrs. John Brown and Co., Atlas Works, are also erecting very large forging presses for a similar purpose.

Messrs. Charles Cammell and Co. have just forged at the Grimesthorpe Steel Works, under the 30-ton hammer, what is believed to be the largest steel forging in one piece made in England up to the present time. It is for the cylinder of a forging press made to the order of Sir W. G. Armstrong, Mitchell, and Co., of Elswick Works, Newcastle-on-Tyne. The weight of the ingot was upwards of 43 tons, and the diameter about 60in. It was cast hollow and forged to a bottle-necked shape, the forging of which is 14ft. long and the weight about 32 tons. The finished dimensions of the bore are about 3ft. The forging, which was shown to me on Saturday, looked a fine piece of work worthy of the company that produced it. The Elswick firm has been in the habit of getting steel tubes for guns from Sheffield for many years, but it would now appear as if they had determined on manufacturing their own.

Messrs. Latham Brothers, of No. 1, Eldon-street, have invented an automatic coupling which is exciting much interest among the makers of railway material. It is adapted either for passenger or mineral traffic, and can be easily attached to the existing appliances. All the coupling or uncoupling can be effected from the outside, thus obviating the necessity for the coupler or shunter to get between the wagons or carriages—a practice which has proved a fertile source of fatal accidents. The invention consists of a hook carried between the two sides of a draw-bar head; the hook can turn upon a strong pin, which is passed through the sides of the draw-bar and the hook towards the front end, and is prevented from so turning by a cross-pin passing through the same parts at the rear end. The cross-pin is connected at one end to a lever and a short arm upon a rocking shaft extending across the carriage frame, and which may be turned from either side by suitable handles. One short movement of the handle withdraws the cross-pin from the hook; the opposite movement replaces it. To the projecting ends of the pin upon which the hook turns the coupling link is secured, but it is prevented from hanging down vertically by projections or studs upon the sides of the draw-bar, which support it at an angle, so that it forms an incline leading up to the curved front of the hook. When two carriages thus provided are forced together, the point of the highest link travels up the other link and over the curved head of the hook until it drops over the point, thus coupling the two carriages. To uncouple it is only necessary to turn the handle of the rocking shaft, which draws out the cross pin and at once releases the hook, so that it can turn up and set free the link of the next carriage. To tighten up carriages so coupled, the draw-bar is extended beyond the usual conical or volute spring inside the framework of the carriage, and a second rocking shaft is so placed that when turned by handles on either side of the carriage, a cam will act against the end of the draw bar, and force it forward into a suitable position for coupling. When coupled the pressure of the cam is withdrawn, and the action of the conical or volute spring draws the carriages tightly together.

A Midland express from Glasgow to London, due at Sheffield at 4.53 last Sunday morning did not arrive till the afternoon, fully twelve hours late. It was buried in the snow seventy miles north of Carlisle, and the passengers had rather an unpleasant experience while they were undergoing the process of digging out.

A remarkable machinery accident was narrated to me this week. On Saturday last one of the men working at a drilling machine in No. 2 planing shop at the Atlas Works, Sheffield, had just started his machine for drilling a hole into an iron plate when the head bolt, which fastened the tool into the socket, caught a portion of his clothing and stripped the whole of his garments off him, except his boots, his stockings, his collar, one shirt cuff, and his hat. Singularly enough the man, though thus rendered all but nude, was more frightened than hurt. He clung desperately to the plate with both hands, otherwise if he had flinched an inch he must have been killed.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The iron trade of this district still drags on in much the same depressed manner that I have had to report ever since the commencement of the year, with, so far as can be judged from present prospects, very little likelihood of improvement for some time to come. There is a continued absence of any weight of work given out, and large users of iron who have bought are, in some cases, not taking one-fourth of their deliveries, whilst those who are in the market buy only very sparingly from hand-to-mouth. The result is that most of the pig iron makers—even where they are tolerably well sold on old contracts—are putting a considerable portion of their present production into stock, whilst very few of the finished ironworks are kept running more than four to five days a week. Even where there has been a moderate amount of activity in the manufactured iron trade in connection with bridge and girder work, the bulk of the orders have gone into the North of England owing to the extremely low prices which Middlesbrough makers are now quoting, angle iron being delivered into this district at £5 2s. 6d., and good qualities of plates at £5 6s. 6d., figures which neither Lancashire nor Staffordshire makers are able to touch.

There was again a very dull market at Manchester on Tuesday, with a general indisposition on the part of consumers to give out orders, whilst sellers of the common brands of pig iron show an increased willingness to book over the remainder of the year. The basis of quoted prices remains the same as last week, 41s. to 41s. 6d., less 2½, being the average prices asked for good qualities of Lancashire and district brands delivered equal to Manchester, but the general tone of the market is weak, and in most cases makers are prepared to give way upon these figures to secure orders, some brands being obtainable readily at 1s. to 1s. 6d. per ton less. Very few transactions are reported in North Country iron, and prices are little more than nominal, but ordinary g.m.b. Middlesbrough delivered equal to Manchester could be got without difficulty at about 42s. 10d. net cash.

In the finished iron trade the average basis of quoted prices is about £5 10s. for good qualities of Lancashire and North Staffordshire bars, £6 for hoops, and £7 for sheets, delivered into the Manchester district. The offer of anything like good specifications would, however, in most cases secure a concession upon these figures, and in a good many instances orders could be placed at 2s. 6d. per ton less.

The leading branches of the engineering trades in this district are being kept fairly well employed, locomotive and railway carriage builders being still busy, and, so far as employment is concerned, it is being better maintained than in most other districts. It is, however, only in exceptional cases that there is any large weight of work ahead, and the general anxiety to secure new work induces so keen a competition for any orders in the market that it almost goes without saying that when they are got, they are scarcely worth the having, except to keep works going.

I understand that Messrs. Mather and Platt, of Salford, have in hand the construction of the large hydraulic lifts to be used in the Mersey Tunnel for raising the railway trains. The firm are also very busy on electric engineering work.

Messrs. Thos. Hetherington and Co., of Manchester, have just completed a number of tire-boring lathes and wheel lathes for the North-Eastern Railway Works at York. In the tire-boring lathes a special feature has been introduced for throwing the machine out of gear so as to facilitate the chucking of the tires. The driving is effected in the ordinary way by worm and worm wheel, and to enable the worm to be readily moved out of gear when required, the worm shaft is carried on two sliding blocks working on each side the bed, and these blocks are moved by a cross shaft and links coupled to levers on the main cross shaft. When the worm is in its working position the levers are down on their centre, thus locking the worm in position, and it is thrown out of gear by a cross handle in a convenient position on the side of the bed. The self-acting motion is self-contained, and consists of a feed disc, rocking shaft, and quadrant pulley, feeding both sides.

Several large power-travelling cranes of from 20 to 25 tons, which Messrs. Hetherington have in hand, also contain one or two improvements. The whole of the working parts are being made of steel, and the gearing for rope-driving and effecting the various motions is being carried in a neat framework consisting of two cast iron sides braced together, and which brings the gearing into a much more compact form than is usually the case. The crabs are also provided with an auxiliary barrel for doubling the speed for quick light lifts when required, and which is readily brought into gear when needed.

The annual dinner of the local members of the Institute of Civil Engineers was held on Friday last at the Queen's Hotel, Manchester, the chair being occupied by Mr. E. Leader Williams. After the usual toasts had been given various suggestions were made and considered with the view of promoting a closer and more intimate association of members resident within the district. Several suggestions were also put forward as to whether it might not be possible to secure the representation of the various important provincial districts on the Council of the Institute. Prior to the dinner, by the courtesy of the Manchester Corporation and the Lancashire and Yorkshire Railway Company, visits were paid to the new gasworks at Bradford, the works of the health department at Beswick, and the carriage works of the Lancashire and Yorkshire Railway at Newton Heath, the inspection of which under the guidance of the respective works' superintendents afforded much pleasure to the members.

In the coal trade there is still only an extremely dull demand for all descriptions of fuel, with a downward tendency in prices. Although no general announced reduction in prices is at present contemplated or probable, there is constant giving way here and there to secure orders or to force sales to clear away stocks that represents, in the aggregate, an almost general lowering in prices, so far as buyers of anything like quantities are concerned. All classes of round coal, both for house fire and steam and iron-making purposes, are bad to sell, and for engine fuel there is only a moderate enquiry, which is fully met by the present limited production. It is only in exceptional cases that pits are working more than four days a week, and even with this restricted output supplies are in excess of requirements. At the pit mouth prices average about 8s. 6d. to 9s. for best coals, 7s. to 7s. 6d. for seconds, 5s. 6d. to 6s. for common, 4s. 6d. to 5s. for burgy, 3s. 9d. up to 4s. 3d. for best slack, with common sorts to be got at 2s. 6d. to 3s. per ton.

In the shipping trade there has been a considerable falling off, and the business doing at the ports in the Mersey is reported to be extremely small, with good qualities of steam coal offering at 7s. per ton for delivery at the high level, Liverpool, or the Garston Docks.

Barrow.—There is no variation to note in the quiet state of the hematite pig iron trade of this district. Business is very languid all round, and orders are slow in coming to hand alike from home and foreign consumers. The business in the hands of makers is comparatively large, but these is no probability of an increase at present, and it is observable that although some of the furnaces have been put out of blast, stocks have not materially decreased, while deliveries have been a low average. The value of hematite pig iron remains at a low point, 44s. per ton being the quotation for mixed parcels of Bessemer pig iron net at works, prompt delivery, while forge and foundry iron are quoted at 43s. per ton net. Stocks of iron held in warrants are large, and at most of the works in the district there is a very large accumulation of pig iron. The steel trade is weak, and although makers are well sold forward, they are not for the moment receiving as many orders as represents the output of their works. The business doing in railway steel is still restricted, but it is thought large puchases will soon have to be made, especially on foreign account, while the action of the steel makers who are combined for protection is gradually having the effect of bringing into the market orders for consignments of steel which have been withheld for a long time, but which must now sooner or later be placed in the hands of makers. There is no new feature to note in the shipbuilding trade, and no new orders have been booked. Finished iron is in poor request. Iron ore dull and prices low. Coal and coke quiet, and prices are low. Shipping very quiet. The engineering industries in the district are better off for orders than of late.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

During last week the price of No. 3 g.m.b. fell about 3d. per ton. Merchants, and also some of the makers, conceded this. At the market held at Middlesbrough on Tuesday last there was an unusually good attendance. Although the amount of business done was not large, the tone was less gloomy than it has been for some time, and no further reduction in prices was made. Merchants offered No. 3 for prompt delivery at 34s. 3d. per ton, but were less eager to sell at that figure than they were at the end of last week. For forward delivery they now ask 34s. 6d. Some makers are offering No. 3 at 34s. 6d. per ton for prompt delivery; but the principal firms will not accept less than 34s. 9d., and even demand 35s. Forge iron is scarce, and the price is steadily maintained. For small lots the leading makers still ask for and obtain 33s. 6d.

There is no demand for warrants, although the price has been reduced to 34s. per ton.

In Messrs. Connal and Co.'s pig iron store at Middlesbrough the stock on Monday last was 50,982 tons, being a reduction of 337 tons for the week. Their stock at Glasgow is increasing, the quantity held on Monday being 585,972 tons.

Shipments of pig iron from the Tees are improving. The quantity sent away up to Monday last was 52,340 tons, as against 41,071 tons in the same period of last month. Fully one-half of the above was sent to Scotland, and of the remainder a large proportion went to Germany.

Nothing new can be reported of the finished iron trade. The demand continues very slack, and the competition for the small orders which are from time to time given out is keener than ever. Prices remain about the same as quoted last week, viz.: Ship plates, £4 15s. to £4 17s. 6d. per ton free on trucks at makers' works; angles, £4 10s. to £4 12s. 6d.; and common bars, about £5. Payment, cash 10th, and less 2½ per cent.

At a meeting of the Cleveland Ironmasters' Association, held at Middlesbrough on Monday last, it was decided to continue the existing arrangement for restricting the make of Cleveland pig iron. It was intimated that, unless the trade shows some signs of improvement shortly, steps will be taken still further to restrict the output.

The permanent way of the new Scarborough and Whitby Railway has been completed as far Robin Hood's Bay, from the Whitby end.

The shipwrights, joiners, and smiths employed in the Wear shipbuilding yards came out on strike on the 19th inst., against a notice on behalf of the employers for a reduction of wages. The reduction asked for is from 2s. to 3s. per week, and is coupled with lengthened working hours, to take effect from Wednesday next. A deputation of the workmen affected had an interview with the Sunderland Shipbuilders' Association on the 23rd. After considerable discussion, the employers agreed to withdraw their demand for an extension of hours, but adhered to that for a reduction of wages. It is expected that the men will agree to this compromise, and will resume work at once. They have, on sentimental grounds, a strong objection to any alteration of working hours.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been considerable animation in the Glasgow iron market this week. Not that there has been much additional inquiry on the part of consumers, but a larger quantity of warrants than usual has changed hands, in consequence of reports which, if correct, would considerably affect the condition of business. One of these rumours is to the effect that a number of furnaces may probably be damped out ere long, and another presages an improvement in the iron and steel industries of the United States. How far they are worthy of credit it is impossible to say; but the transactions hitherto resulting from them are for the most part purely speculative. During the week the stock of pig iron in Messrs. Connal and Co.'s stores has increased by 2220 tons.

Business was done in the iron market on Friday up to 41s. 3½d. cash. Monday's market was quiet, at 41s. 1d. to 41s. 2½d. cash. On Tuesday forenoon warrants advanced to 41s. 5½d., but subsequently receded to 41s. 3½d. On Wednesday the market was fairly active at 41s. 3d. to 41s. 6d. cash. To-day—Thursday—the quotation further advanced to 41s. 7d., but this figure was not maintained at the close.

The market values of makers' iron are:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 52s.; No. 3, 46s. 6d.; Coltness, 55s. and 50s. 6d.; Langloan, 54s. 6d. and 51s.; Summerlee, 51s. 6d. and 51s.; Calder, 52s. and 46s. 6d.; Carnbroe, 49s. and 46s.; Clyde, 47s. and 43s.; Monkland, 42s. 6d. and 40s.; Quarter, 42s. and 39s. 6d.; Govan, at Broomielaw, 42s. 3d. and 40s.; Shotts, at Leith, 51s. 6d. and 51s.; Carron, at Grangemouth (specially selected, 52s. 6d.), No. 3, 47s.; Kinneil, at Bo'ness, No. 1, 44s. 6d.; No. 3, 43s. 6d.; Glengarnock, at Ardrossan, 48s. 6d. and 42s. 6d.; Eglinton, 43s. and 39s. 6d.; Dalmellington, 47s. and 43s. 6d.

The engineering and ironfounding departments continue quiet. A few orders are coming to hand, but they are accepted at very low rates, and the tone of business does not indicate the least tendency towards improvement.

For steel the inquiry is satisfactory, considering the backward condition of trade, and the steel works are steadily employed, although not, of course, to the full extent of their capacity.

The past week's shipments of iron manufactures from Glasgow embrace three small locomotives, valued at £5100, for Bombay; £4500 worth of machinery, £3700 sewing machines, £1800 steel goods, and £25,000 general iron manufactures. These figures indicate that the different branches of trade with which the goods in question are connected are in a declining state. Had the decrease in shipments extended only over one or two weeks, it might have been supposed that it was accidental; but the repetition of the small shipments week after week indicates that business is suffering a general relapse.

The coal trade is less active in all its departments. For household use there was some additional demand a few days ago, but owing to dull trade the working classes, who, of course, compose the great body of the consumers, are obliged to be content with limited supplies. The shipping trade has been quiet and decreasing in amount. In the past week between 13,000 and 14,000 tons of coals were despatched from Glasgow, 6729 tons from Troon, 9690 from Ayr, 2500 from Grangemouth, 4523 from Irvine, and 2582 from Greenock. Business is slackening in the Lanarkshire coalfields. At Leith it is reported that a good many inquiries are being received for coals for forward delivery, and that several contracts to meet these have been placed with west country coalmasters. The shipping trade at Burntisland is proving very disappointing to the Fife coalmasters. Some of their competitors on the south side of the Forth allege that the Fife masters have brought the dullness upon themselves by their combination. The Fife coalmasters, on the other hand, attribute their want of success to the more favourable railway rates and arrangements on the other side of the Firth, and they are agitating for a reduction of harbour dues at Burntisland, or, in lieu of this, a decrease of carriage charged by the North British Railway from the collieries to the harbours.

WALES & ADJOINING COUNTIES.

(From our own Correspondent.)

THE coal trade has again become easier, and a great falling off taken place with regard to foreign coaling depôts.

I learn from one of the principal Cardiff shippers that the easy freights which have existed so long have led to the filling up of those depôts in a most wholesale manner, and there must now be a great demand that would necessitate anything like brisk consignments from Wales. It was the easy freights, he maintained, and not Barry diplomacy, which led to this heavy stocking. Constantinople 6s. 6d., Malta 7s. coal rates still continue. One of the most remarkable rates I note is that for foreign ore from Bilbao, 4s. 6d.! It is evident that this does not pay, and is only continued in working out contracts. There never was a better time for securing iron ore from Spain than at present, as the delivery price at Cardiff is now down to about 12s. 6d. per ton.

In the present dull time of the coal trade, which I note as most visible in the house coal districts of Monmouthshire and amongst the collieries of the leading ironworks, great interest is being shown in organising against the Railway Rates Bill, and a very influential meeting is called for on Saturday next at Cardiff. The promoters intend to subscribe a substantial sum, so as to carry on an effective opposition. One of the principal points of the Bill is to legalise terminal rates, which, though exacted upon some lines, are not generally understood as being illegal. This Mr. Pope showed the Taff Vale clearly some time ago, and since then this company have avoided terminal contentions, and compromised by a slight increase in another direction.

Our contemporaries, *Nature* and the *Lancet*, are exercising themselves of late on the question of our coal exhaustion, and it appears to be accepted that at the present rate of increase—namely, 3,000,000 tons annually—about 261 years would see the practical ending of coal working. But it would appear that this is too lenient a view, and that a progressive increase must be taken into consideration, which would reduce the time to 106 years.

The *Lancet* rather uncommercially suggests the prevention of foreign export! The present opinion amongst several of the prominent mining engineers of Glamorgan is that the Rhondda Valley will be worked out in fifty years, when other Rhonddas will be found—Taff Bargoed to wit. The deep measures of Monmouthshire are in many valleys still virgin.

A strong company is about sinking to the West of Pontypridd. This will make three great and deep colliery speculations which will take some years to work before coal is struck and on the bank.

I am glad to see that our capitalists in the coal trade are not discouraged by the present slackness. They know that it is only temporary—that, in fact, it is the result of the grand harvest we had in England last year. The farmers benefitted by this, but our coalowners did not. There was, for instance, a lessened import of some millions of tons of produce. This meant the lessened working of thousands of steamers and a great falling off in coal shipment and uses in bunkers.

In connection with our iron trade, I hear a whisper of a possible "boom." American advices report steady improvement, and a good authority there who announced the boom of 1877-8 predicts another. Well, the Welsh steel makers are well posted to meet it. Immense stocks of raw material are in hand, and labour is abundant.

The Cyfarthfa Steel Works are employed upon a rail order. Many of the chief works are occupied at the usual half-time rate, and this, with improvements, keeps an appearance of briskness. Steel makers, it must be confessed, say that orders are very slow in coming in, and that the outlook is bad; but when I see stocking carried on with energy, and immense sums expended in modifications, the impression is strong that more hopefulness is felt than expressed.

In tin-plate there is a decided improvement going on. Prices are hardening, and the demand is on a steady increase. Last week a quantity of tin-plate was sent from Newport to Bilbao. This week from the Swansea district 1200 tons were sent to New York, 240 tons to San Francisco, 350 tons to Italy, and a small cargo to Lisbon. A good feature about the trade is that while prices are stiff makers are very resolute in refusing to make forward contracts. Makers of best brands are very firm; buyers who waited until a low figure was touched are pressing.

There is no change at Treforest Works. These suffered from the preference shown of late for steel plate, but if no improvement can be found in "spot" eradication, I shall not be surprised at the old-fashioned plate again coming into demand—and this Treforest, with its excellent pig, could well meet.

Coal prices rule from 9s. 6d. to 10s. 6d. for colliery screened; No. 2 fetches 8s. 6d. per ton; No. 3, 9s.; small steam is in better demand at 4s. 6d. best samples; moderately good yield, 4s.

Patent fuel is in brisk demand at Swansea and Cardiff. Swansea is particularly busy in this trade. Last week the shipping trade there was very active, and 130 steamers and sailers came into port. The Chamber of Commerce at Swansea is entering into arrangements for opposing the Railway Rates Bill.

I am glad to hear that there is a prospect of starting the Merthyr Wire Works again. The machinery there is of first excellence.

Newport is moderately busy; the export of coal last week was slightly in excess of 50,000 tons, and one cargo of rails for Calcutta—1800 tons—was sent off.

Ship repairing yards are well occupied, rates to France dull.

Pit-wood is coming in freely to the chief ports, and prices are in consequence easy.

The manager of the Ynyshir Colliery, the Test colliery, has found his way to America, but is to be sent for.

The Rhondda colliers and those of other districts are holding meetings in order to assist the Birmingham gathering at the forthcoming national meeting of miners.

Mr. Walker is making satisfactory progress at Barry, and already the transformation is great.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

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

Applications for Letters Patent.

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

17th February, 1885.

2140. PRODUCING DESIGNS ON REVERSIBLE FABRICS, W. B. Robertson and W. Walker, London.
2141. COMPRESS SLIDE for WIRE, &c., G. P. Lemprière, Birmingham.
2142. MAGIC LANTERN PICTURES, A. Cowan, London.
2143. DOUGH MIXING MACHINES, T., J., T., and J. Vicars, Liverpool.
2144. DISPLAYING ADVERTISEMENTS, &c., F. James, Dresden.
2145. READING LAMPS, S. Lawrence and H. Tibbins, Birmingham.
2146. ELECTRICALLY OPERATED VALVES for WASTE-NOT CISTERNS, &c., M. Syer, Peckham.
2147. AUTOMATIC BRAKE, J. Chew, Blackburn.
2148. SOUNDING APPARATUS, J. B. Hannay, Glasgow.
2149. VELOCIPEDES, E. Marshall and G. Phillips, Aston.
2150. PRESSES for EXTRACTING OIL, &c., W. P. Thompson.—(*F. Jourdan, France.*)
2151. RODS for CLEANING RIFLE BARRELS, W. Lightwood, Birmingham.
2152. YOKE for ANIMALS of BURDEN, J. Anderson, Monifieth.
2153. HYDRAULIC CEMENT, L. A. Brodo and T. T. Rankin, Glasgow.
2154. DRAW PLATE, J. Shaw, Halifax.
2155. SILOS, J. S. Robertson, Glasgow.
2156. TOWING and ANCHORING SHIPS, &c., J. McHardy, Glasgow.
2157. LEVELLING, &c., SHEET and PLATE METAL, J. W. Britton, London.
2158. ARTIFICIAL LEATHER, E. M. Freeley, London.
2159. MECHANISM for CONVERTING MOTION, A. M. Clark.—(*J. E. Pencille and S. C. Rhodes, United States.*)
2160. WALL, &c., DECORATIONS, E. G. Colton.—(*J. Klee, United States.*)
2161. TREATING SLURRY or SLIP, H. Faija, London.
2162. ELECTRIC LIGHT SWITCH, A. P. Lundberg, London.
2163. CUFF FASTENERS, A. M. Clark.—(*J. J. Fay, United States.*)
2164. LIFTING JACKS, J. H. Johnson.—(*U. Rousseau, France.*)
2165. ELECTRICAL BATTERIES, J. T. Armstrong, Hanley.
2166. STOVES, M. Malvin and W. W. England, London.
2167. EXHAUSTING SEWER GAS from SEWERS, &c., M. Malvin, London.
2168. ELECTROTYPE PLATES, A. W. Marshall and the American Press Association of Chicago, London.
2169. PURIFYING COAL GAS, A. Dempster, London.
2170. SIFTING MACHINES, G. Waller, London.
2171. HANDLES for KNIVES, &c., T. H. Heard, Sheffield.
2172. PORTABLE or TRAVELLING STOOL, E. Müller, Halifax.
2173. PURIFYING SEA WATER, T. Kay, Stockport.
2174. MAKING PAPER BOXES, L. A. Groth.—(*S. Junghaus Germany.*)
2175. FIRE-GRATE, L. A. Groth.—(*M. Bader, Austria.*)
2176. GLOVE FASTENER, L. A. Groth.—(*A. Köhler, Germany.*)
2177. ELECTRIC ARC LAMPS, L. A. Groth.—(*H. Pöje and E. Fischinger, Germany.*)
2178. DOUBLE WORKING CHAIN STOOL, L. A. Groth.—(*C. Eberhardt, Germany.*)
2179. WALKING-STICK UMBRELLA, L. A. Groth.—(*I. M. Tintoré, Spain.*)
2180. KNITTING MACHINES, L. A. Groth.—(*G. F. Grosser, Germany.*)
2181. SUPPORTS for ROCK DRILLS, A. J. Boult.—(*C. S. Westbrook, United States.*)
2182. MAKING FABRIC GLOVES, J. Haines and A. Yates, London.
2183. CLEANING SINKS, &c., A. J. Boult.—(*L. O. Howell, jun., United States.*)
2184. FUSE, F. Pfund and A. Schmid, London.
2185. ROCK DRILLS, A. J. Boult.—(*C. S. Westbrook, United States.*)
2186. PRESS, H. A. Howman, London.
2187. BELL-WORK FITTINGS, R. G. Evered, London.
2188. MAGNETO CALL BELL APPARATUS, H. T. O. Fraser and F. Young, London.
2189. FOLDING GATES, A. W. L. Reddie.—(*W. W. Bostwick, United States.*)
2190. OBTAINING GAS from HYDROCARBONS, A. Gutensohn, London.
2191. UPSETTING and BENDING METALLIC OBJECTS, P. Jensen.—(*Kjobenhavn's Hesteskofabrik, Denmark.*)
2192. STOPPER for AERATED WATER BOTTLES, F. C. Roberts, London.
2193. SOLIDIFICATION of PHOSPHORIC ACID, F. Barbe, London.
2194. ELECTRIC RAILWAYS, S. Pitt.—(*L. Daft, New Jersey.*)
2195. CONVEYORS, S. W. Rowell, London.
2196. TREATMENT of TOOL STEEL, R. Hadfield, London.
2197. OBTAINING MOTIVE POWER, J. Martin, Richmond.
2198. SCREW PRESSES for EXTRACTING OILS, J. C. Thompson, London.
2199. INTERMITTENT SIPHON APPARATUS, J. A. Bean, London.
2200. SEWING MACHINE for STITCHING a CORRUGATED STRIP on the LINING of HATS, &c., W. F. Thomas, London.
2201. PREVENTING RAILWAY ACCIDENTS, G. F. Redfern.—(*J. Duboc, France.*)
2202. FELT HATS, J. Eaton, London.
2203. ROCK DRILL MACHINES, R. Stephenson, London.
2204. PENCIL CASES, C. E. Little, E. G. Johnson, J. Pulley, H. F. Stewart, and H. L. Symonds, London.
2205. REGULATING the ADMISSION and EXCLUSION of LIGHT in PHOTOGRAPHIC CAMERAS, &c., C. Groombridge, London.
2206. PRODUCING SOLUBLE COMBINATIONS of CERTAIN AZO COMPOUNDS with BI-SULPHITES, H. J. Haddan.—(*E. Frank and the Farbenfabriken vorn F. Bayer and Co., Prussia.*)
2207. SCALES, H. J. Haddan.—(*R. Watson, United States.*)
2208. PREPARING ANIMAL FOOD, W. R. Lake.—(*F. W. Wisebrock, United States.*)
2209. BOLSTER and STEP BEARINGS for SPINDLES, W. R. Lake.—(*J. A. Metcalf, United States.*)
2210. DESTROYING INSECTS on PLANTS, &c., C. T. Kingzett, London.
2211. STIRRUPS, E. Edwards.—(*J. Pochet, France.*)
2212. FASTENING for HOLDING the SLEEVES of DRESSES, &c., G. Harry and W. Herbert, London.
2213. SUPPORT for CARRYING RIFLES, G. Shepheard, London.
2214. REVOLVING MAGAZINE FIRE-ARM, G. Shepheard, London.
2215. FEED MECHANISM for CHAIN-STITCH SOLING MACHINES, H. J. Haddan.—(*C. Mansfeld, Saxony.*)
2216. TESTING QUALITY of FLOUR, H. J. Haddan.—(*K. W. Kunis, Saxony.*)

18th February, 1885.

2217. PRODUCING DESIGNS on FABRICS, W. Ireland and J. E. Thurman, Manchester.
2218. WIRE LETTER RACK, A. E. Busby, Birmingham.
2219. CONSTRUCTING BEATERS for FLOUR MACHINES, J. D. Tomlinson and T. Voss, Rochdale.
2220. ROLLERS for BLINDS, &c., E. Wright, Northampton.
2221. REVERBERATORY FURNACES, T. L. Ellis, Glasgow.
2222. JEWELLERY, T. Wilcox, Birmingham.
2223. SECURING SLATES to ROOFS, J. T. Gibson, London.
2224. SUPPLYING OIL to WICKS, E. L. Fenby, Sutton Coldfield.
2225. TIME-TABLES, W. Kloen, Birmingham.
2226. SHIPS' BERTHS, &c., R. Harrison, Liverpool.
2227. FELLOES, &c., J. Standfast, Taunton.
2228. PRESERVING RAIN WATER, A. Lovell, Higham Ferrers.
2229. COVERS of JUGS, &c., J. Jarvis, Burslem.
2230. AUTOMATIC CUT-OFF MECHANISM for SLIDE VALVES, J. H. Tangye and W. Johnson, jun., London.
2231. METALLIC ENCLOSURES for SILOS, &c., W. Baylis, London.
2232. WATER VELOCIPEDE, C. Blagburn, London.
2233. LATH BACKING for PLASTER WORK, H. Cleave, London.
2234. STEAM ENGINES, E. Field, London.
2235. VALVES, S. Smith, London.
2236. VARIABLE AUTOMATIC EXPANSION MOTION for STEAM ENGINES, H. S. Greenwood, Halifax.
2237. BRONZING PAPER, &c, R. F. Phillips, J. Sternberg, and T. L. Archer, London.
2238. PROTECTING the KNEES from INJURY while KNEELING, E. Dunmere, Chiswick.
2239. PACKING and CONVEYING EGGS, W. Middleton, London.
2240. BICYCLES, A. and A. Neilson, London.
2241. PHOTOGRAPHIC SHUTTERS, &c., F. W. Branson, London.
2242. SELF-SUPPORTING PORTFOLIO and STAND, P. T. Johnson, London.
2243. PRESERVING FISH in FISHING SMACKS, A. Egestorff and L. Hermann, London.
2244. SPEED INDICATOR, K. W. Hedges, London.
2245. BLANKETS and HORSE CLOTHING, G. L. Stocker.—(*J. Broadhead, U.S.*)
2246. HAIR and FIBRE CARDING MACHINES, C. Gauntlet, London.
2247. CHIMNEY-POT, J. Horne and S. Hollyman, London.
2248. IRONING, &c., FABRICS and other MATERIALS, M. Heslop, London.
2249. REMOVING WATER from the BALLAST TANKS of SHIPS, &c., W. B. Thompson, London.
2250. PORTABLE FILTERS, F. R. Lipscombe, London.
2251. TWISTED IRON ROD, R. Gigot and E. Hübner, London.
2252. HYDRAULIC CRANES, C. Davy, London.
2253. BEER ENGINES, T. F. Kelly, London.
2254. CARRIAGE JACKS, W. R. Lake.—(*A. J. Church, United States.*)
2255. PREVENTING the FRACTURE of CYLINDERS, &c., of ENGINES, W. R. Lake.—(*J. Smeets, Belgium.*)
2256. LACE, W. Lawrence and I. Elliott, London.
2257. SKEWERS for PREPARING, &c., FIBROUS SUBSTANCES, A. Wood, Middleton.—16*th February*, 1885.

19th February, 1885.

2258. FLESHING, &c., HIDES and SKINS, J. E. Dixon, London.
2259. PREVENTING STOVES from CRACKING, T. Cudlipp, London.
2260. ADJUSTABLE LOCKING SPANNER, W. G. Crosskey and J. C. Robertson, Prior's Keston.
2261. BOOKS for TAKING PRESS COPIES of LETTERS, &c., C. W. King, Southport.
2262. RECUPERATIVE GAS BURNER, B. H. Thwaite, Tranmere.
2263. WATER-TIGHT BOXES, E. W. Beckingsale, London.
2264. AUTOMATIC SAFETY COUPLING, A. W. Turner and T. Greatrix, Birmingham.
2265. ATTACHING a PHOTOGRAPHIC CAMERA to a TRICYCLE, D. H. Cussons and W. T. Turner, Liverpool.
2266. STEREOTYPING, A. E. Ragg and F. Coplestone, Chester.
2267. BREECH-LOADING SMALL-ARMS, W. H. Greenwood, Halifax.
2268. DIFFERENTIAL GEARING, M. H. Smith, Halifax.
2269. STOPPERING BOTTLES, F. A. Bird and J. B. Fenby, Birmingham.
2270. INCUBATORS, W. Muir, Glasgow.
2271. ELECTRIC CURRENT METERS, J. W. Swan, London.
2272. COFFER DAMS, W. T. Creed and A. Causton, St. Leonard's-on-Sea.
2273. VENT PEG, J. Hammond, London.
2274. PLAYING and other CARDS, J. W. Hoffman, London.
2275. ORNAMENTING GELATINE, A. Mullord, London.
2276. WATER MOTORS, S. S. Allin, London.
2277. TIGHTENING WIRE, J. C. Graham and K. W. Hedges, London.
2278. GAS BURNERS for HEATING and COOKING, J. J. Royle, London.
2279. CHARM or APPENDAGE for WATCH CHAINS, &c., A. Wilcox, London.
2280. INCREASING the PROPELLING POWER of MACHINERY, F. and A. Foulston, London.
2281. DRIVING BELTS, A. G. Brookes.—(*C. O. Gehrckens, Germany.*)
2282. AGRICULTURAL MANURES, G. A. Jarvis, London.
2283. EXTRACTING POTASH from FELSPAR or FELSTONE ROCKS, G. A. Jarvis, London.
2284. SLIDE VALVES of STEAM ENGINES, E. C. Peck, Old Charlton.
2285. FRAMES for MOUNTING PHOTOGRAPHS, J. Goodby, London.
2286. TROUSER STRAP for RIDING, A. J. Emery, London.
2287. ELECTRICAL ACCUMULATORS, T. S. Sarney and A. S. Hamand, London.
2288. PUMPING HIGHLY RAREFIED ELASTIC FLUIDS, A. G. Southby and F. D. Blyth, London.
2289. CRUCIBLE FURNACES, A. Wilson, London.
2290. PACKING EGGS for TRANSPORT, H. R. Purvis, London.
2291. COAL STAITHS, W. Price, London.
2292. PULSOMETERS, J. L. Berry, London.
2293. COMBINED BEDSTEAD, TOILET-STAND, &c., G. Angus, London.
2294. GREASE TRAPS, R. C. Fulton and J. Findlay, London.
2295. MAGIC LANTERN SLIDES, R. L. Sleater, London.
2296. NAVIGATING CANALS, A. J. Boult.—(*M. Nougués, France.*)
2297. FIRE-ESCAPES, A. J. Boult.—(*R. de Elorriaga y Rivas, Spain.*)
2298. MEASURING LIQUIDS, J. Fawcett, London.
2299. REGULATING DRAUGHT in FURNACES, J. A. Macmeikan, London.
2300. OPENING AERATED LIQUID BOTTLES, H. Codd, London.
2301. STOPPERING AERATED LIQUID BOTTLES, H. Codd, London.
2302. MEASURING INSTRUMENTS, R. Montgelas.—(*A. Prüsker, Austria.*)
2303. FIRING FURNACES, &c., C. D. Abel.—(*J. and C. J. Haswell, London.*)—18*th June*, 1884.
2304. DECORATING, &c., WALLS, J. A. Turner, London.
2305. ABDOMINAL BELT, A. M. Clark.—(*M. Maintenay, France.*)
2306. KITCHENERS, H. Hunt, London.

20th February, 1885.

2307. PRINTING and EMBOSSING, A., I., and R. Kay, Manchester.
2308. DRIVING the SPINDLES of SPINNING, &c., MACHINES, J. Elce, Manchester.
2309. PREVENTING SHIPS from FOUNDERING, &c., F. P. Warren, Cosham.
2310. DECORATING GLASS ARTICLES, J. Northwood, Kingswinford.
2311. PRESSING or IRONING FABRICS, W. Bash and M. A. Prenslan, Liverpool.
2312. HOT WATER SUPPLY APPARATUS, J. Butterworth, Manchester.

2313. SANITARY and other PIPES, &c., R. and W. Welford, and J. Scott, Sunderland.
2314. SEATING CLOTH for UPHOLSTERY, G. P. Lee, Manchester.
2315. WOOD-CUTTING MACHINES, J. Bewick, Sunderland.
2316. TRAPS for SNARING ANIMALS, &c., G. D. Wood, Wolverhampton.
2317. WIRE NETTING MACHINES, E. S. Bond and S. W. Johnson, Birmingham.
2318. PROMOTING, &c., COMBUSTION in FIREPLACES, H. Walker, Birmingham.
2319. WATER PIPES, &c., T. G. Normanton, Barrow-in-Furness.
2320. STEAM SAFETY VALVES with PRESSURE GAUGE, I. and S. Smith, Nottingham.
2321. MOWING and REAPING MACHINES, S. B. Bamford, Uttoxeter.
2322. SELF-STOPPING, WARPING, &c., MACHINES, P. Brimelow, Bury.
2323. SOLDERING IRONS, G. Oulton, Liverpool.
2324. EXTINGUISHING APPARATUS for LAMPS, W. G. Richardson, London.
2325. ARMATURES for DYNAMO-ELECTRIC MACHINES, F. Wynne, London.
2326. ATTACHING DOOR HANDLES, J. E. Smith, London.
2327. SUCTION VALVE for ARTIFICIAL TEETH, J. O. C. Phillips, London.
2328. ARMATURES of ELECTRO-MAGNETS, J. Stephen, Glasgow.
2329. SUGAR, J. Laidlaw, Glasgow.
2330. REVOLVING LAMPS, A. C. Henderson.—(*P. Lauras, France.*)
2331. AUTOMATIC FIRE EXTINGUISHERS, T. Witter, London.
2332. GAS PRESSURE REGULATORS, C. Ulbrich, London.
2333. DETACHABLE HANDLE BAR for VELOCIPEDES, G. Woodcock and W. Phillips, London.
2334. CARTRIDGE CASES or SHELLS for SMALL-ARMS, B. G. D. Cooke, London.
2335. TELEGRAPHING from LIGHT SHIPS, &c., to the SHORE, J. H. Barry, London.
2336. SAFETY BOTTLE BOX and DRAINER, W. Shepherd, London.
2337. FIRE-ARMS, L. Armanni, London.
2338. TREATING STEEL INGOTS, J. Gjers, London.
2339. BLOWN GLASS BOTTLES and MOULDS, E. M. Knight, Halifax.
2340. BLOWN GLASS TAPS and MOULDS, E. M. Knight, Halifax.
2341. CLIP with BUCKLES for HOLDING the TONGUE of STIRRUP LEATHERS, T. Hetherington, London.
2342. SCREENS for SIFTING COAL, E. Lyall, London.
2343. SELF-ACTING CLIP for STRETCHING, &c., TROUSERS, H. Walker, London.
2344. WATER-TIGHT METALLIC CARS, J. Imray.—(*La Société H. Lefebvre et Compagnie, France.*)
2345. FILTERING, L. A. Groth.—(*C. Pieyke, Germany.*)
2346. REFLECTORS and FITTINGS, T. H. Collins, London.
2347. GRADUATED CHEMICAL MEASURES, &c., J. J. Hicks, London.
2348. SECURING ELASTIC BANDS to the COVERS of POCKET-BOOKS, &c., F. Wich, London.
2349. TRUCK and LADDER, A. M. Clark.—(*J. C. Lowen, United States.*)
2350. MAGNETIC COMPASSES, A. M. Clark.—(*Messrs. Favi, Paride, and Co., Italy.*)
2351. PNEUMATIC RAILWAY BRAKES, J. H. Johnson.—(*L. Soulerin, France.*)

21st February, 1885.

2352. FILTRATION and PURIFICATION of FLUIDS, J. G. Lorrain, London.
2353. SECURING BRACELETS, &c., J. Cheshire, Hockley.
2354. SUBSTITUTE for LEATHER, A. Anderson, Paris.
2355. CONDENSERS of MOTIVE POWER ENGINES, W. J. D. Walker, London.
2356. VERTICAL BOILER, E. C. Froom.—(*V. I. Kalashnikoff, Russia.*)
2357. PETROLEUM or LIQUID HYDROCARBON BURNERS, J. Roots, London.
2358. SAFETY CHECK BOLT for WHEELS, T. A. Aston and G. H. Hands, Birmingham.
2359. SADDLES for VELOCIPEDES, W. Woolley, Birmingham.
2360. PROTRACTED SET-SQUARE, H. A. Fletcher, Gravesend.
2361. SELF-DISCHARGING and RIGHTING WAGON, &c., J. Kitto, A. Paul, and R. R. Nancarrow, Llanidloes.
2362. STEAM ENGINES, W. S. Sutherland, Liverpool.
2363. TREATING DOUGH, T. Vicars, sen., J. Vicars, sen., T. Vicars, jun., and J. Vicars, jun., Liverpool.
2364. WATER-CLOSET SEATS or COVERS, P. J. Hanway, Dublin.
2365. PRODUCING PARQUET FLOORING, &c., F. Podany, London.
2366. ENTRENCHING IMPLEMENT, G. G. Purches, Portsmouth.
2367. CHRISTMAS and other GREETING CARDS, J. F. Bennet, London.
2368. PERAMBULATORS, &c., J. Darling and D. Osborne, Glasgow.
2369. LUBRICATORS, E. Rost, London.
2370. LUBRICATORS, W. J. L. Stewart, London.
2371. STRIKING WORK for CLOCKS, &c., C. Hahlweg, London.
2372. MEASURING the PITCH of SCREW PROPELLERS, W. Kinley, Liverpool.
2373. FLUSHING, B. Gordon, London.
2374. SECURING LABELS, &c., T. J. Walsh and W. Lovett.—(*T. A. Martin, Calcutta.*)
2375. SAFETY BICYCLES, P. T. Hill, London.
2376. STEAM STEERING GEAR for SHIPS, J. P. Wilson, London.
2377. SYRINGES, R. Park, London.
2378. GAS STOVES, J. F. Allan and J. Ramsay, London.
2379. SPECIAL LETTER-PRESS PRINTING MACHINES, D. Carlaw, London.
2380. LUBRICATORS, J. Steven and T. Burt, London.
2381. PRODUCING WHITE OIL from BLACK OIL, &c., M. Ayrton, Halifax.
2382. TEMPLES for LOOMS, W., H. E., and J. C. Lupton, London.
2383. METALLIC SLEEPERS, CHAIRS, &c., W. S. Davy, Sheffield.
2384. WATCHES, &c, T. Barry, London.
2385. BUTTONS, &c, J. B. Lallouette, London.
2386. TANDEM VELOCIPEDE, H. J. Hudson, London.
2387. REFRIGERATING APPARATUS, J. Imray.—(*E. Fixary, France.*)
2388. PAYING OUT, &c., SUBMARINE ELECTRIC TELEGRAPH CABLES, W. C. Johnson and S. E. Phillips, London.
2389. CONTINUOUS AUTOMATIC PRESSURE and VACUUM BRAKE APPARATUS, E. Restieaux, London.
2390. LAMP SUSPENSION, F. T. Sale, London.
2391. POLISHING, &c., STEEL ROLLERS, H. J. Haddan.—(*Escher Wyss and Co., Germany.*)
2392. TEA-POTS, &c., A. G. Dowler, London.
2393. FILES for FILING LETTERS, T. Walker and W. M. Perry, London.
2394. PRODUCING MOTIVE POWER, W. T. Whiteman.—(*I. Ramboux, Belgium.*)
2395. RESISTANCE BOXES, G. A. Nussbaum, London.
2396. VELOCIPEDE SADDLES, L. Schmetzer, London.
2397. LUBRICATORS, A. J. Boult.—(*F. L. McGahan, United States.*)
2398. SIGNALLING on RAILWAYS, W. Edmonds, London.
2399. BROOCH and FLOWER HOLDER, H. J. Davis, London.
2400. MOTOR for TRICYCLES, W. Turnbull, London.
2401. MOULDING SCREW THREADS, H. Codd, London.
2402. AERATED BEVERAGE, I. R. Sharpe, London.
2403. PRESERVING or CURING FLESH and FISH, W. G. Gard, London.
2404. CLOSING the MOUTHS of GAS RETORTS, J. F. Braidwood, London.
2405. BUCKLES, W. R. Lake.—(*C. A. Mann and T. B. Sheldon, United States.*)
2406. VALVES for WATER BASINS, &c., W. R. Lake.—(*H. S. Lord, United States.*)

23rd February, 1885.

2407. OIL CLOTHS, H. S. and I. H. Storey, London.
2408. VENTILATING SEWERS, &c., C. Harvey, Preston.
2409. COUPLINGS of RAILWAY WAGONS, &c., T. Mitchell, Keighley.
2410. WATER, &c., PRESSURE ENGINE, J. Ahlstedt, London.
2411. DYNAMOMETERS, A. Budenberg.—(*Schäffer and Budenberg, Germany.*)
2412. SASH CASED WINDOW, J. Tulloch, Inverness.
2413. CONNECTING the SPOKES, &c., of WHEELS, J. Powell, Cornwall.
2414. SLIDING RACKETS for DISPLAYING MEAT, &c., T. E. Gabbedey, London.
2415. DOBBY or SHAFT MACHINE for WEAVING, J. Southworth and J. R. Smith, Preston.
2416. CAP SPINNING MACHINERY, E. J. Oates, Halifax.
2417. STUDS, &c., for ROVING, &c., MACHINERY, E. J. Oates, Halifax.
2418. BRAKING, &c., TRAM-CARS, J. McHardy and J. McGruther, Dollar, N.B.
2419. ENGINES, J. Lapsley, Glasgow.
2420. REGISTERING WATER, &c., H. Thomas, Longton.
2421. INCREASING the WIDTH of WOVEN FABRICS, J. Dykes, Bury.
2422. CONDENSERS, J. B. Edmiston, Walton.
2423. FOLDING PAPER, G. A. Wilson, Liverpool.
2424. GIRDERS, T. Dykes, Glasgow.
2425. ATTACHING METAL ENDS to INDIA-RUBBER SPRINGS, H. Weatherill, Manchester.
2426. DISCONNECTIVE COMPOUND STEAM ENGINES, J. F. Rankin and M. Rankin, Glasgow.
2427. FANCY YARNS, G. A. J. Schott, Bradford.
2428. VELVETEENS, G. A. Shiers, A. Wright, and E. Hadfield, Manchester.
2429. CAB SADDLE SCREWS, S. Crosbee, Birmingham.
2430. EMBOSSING in RELIEF, J. Tulloch, Inverness.
2431. HARNESS BUCKLES, E. Adderley, Walsall.
2432. BUFFER ATTACHMENTS, J. Holmes, Kingston-upon-Hull.
2433. ANTI-FRICTION ROLLER SUPPORTS, T. Robbins and E. French, Birmingham.
2434. FOOT PEDALS for BICYCLES, &c., E. J. Spink, Halifax.
2435. CLEANING BOOTS and SHOES, W. I. Last, London.
2436. SOFT PEDAL MECHANISM for PIANOS, D. F. Downing, Woolwich.
2437. RAILS and FASTENINGS for RAILWAYS, W. B. Quelch, Croft.
2438. FIXING the NECKTIE, A. Adey, London.
2439. HANSOM CABS, E. E. Allen, London.
2440. LAMP BURNERS, J. Dyer, London.
2441. CORSETS, E. Rose, London.
2442. LOOSE PULLEY BOOT LACE HOOK, J. E. Bannister, Lewisham.
2443. ORGANS, H. Willis, London.
2444. TANDEM VELOCIPEDES, J. White and J. Asbury, London.
2445. COAL-CUTTING MACHINES, G. McPherson and G. McPherson, jun., London.
2446. VAN BRAKES, H. P. Dunn, London.
2447. TORCH, H. J. Haddan.—(*J. Dax, Germany.*)
2448. CULTIVATORS, G. Mellor and R. M. Rowley, London.
2449. DRESSING TIN ORES, J. Edwards, G. W. Hannam, and F. H. Lyell, London.
2450. INDICATING NAMES of NEXT STATIONS in RAILWAY CARRIAGES, J. Kendal and M. Laval, London.
2451. PANELS and HANGINGS, M. L. A. Bressac, London.
2452. BRAKE APPARATUS for LIFTS, &c., H. H. Lake.—(*Messrs. Wirth and Co., Germany.*)
2453. VENTILATORS and CHIMNEY COWLS, G. J. and S. T. Messenger, London.
2454. RAISING and LOWERING WEIGHTS, R. F. Anderson, London.
2455. REGULATING TEMPERATURE in DWELLINGS, A. B. Willway, London.
2456. CONTROLLING the DISCHARGE of LIQUIDS, C. D. Abel.—(*A. Kaiser, Switzerland.*)
2457. LADDERS or STEPS, J. Campbell, London.
2458. ELECTRO-TELEPHONIC RECEIVERS A. A. Campbell-Swinton, London.
2459. FILLING and CLOSING BOTTLES, J. Phillips, London.
2460. BOOTS and SHOES, J. Borrett, London.
2461. KNITTING MACHINES, G. F. Redfern.—(*J. Traill, France.*)
2462. REVERSIBLE MACHINE for CLEANSING FOOT-PATHS, &c., E. C. B. Tudor, London.

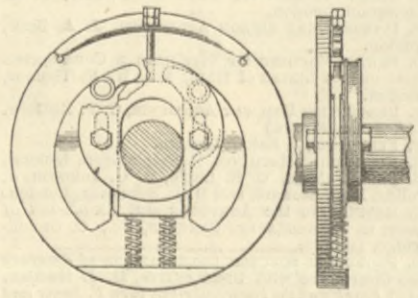
SELECTED AMERICAN PATENTS.

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

310,363. STEAM ENGINE GOVERNOR, *George W. Bigelow, New Haven, Conn.—Filed September 1st*, 1884.

Claim.—(1) The combination of the shaft of the engine, a disc or plate made fast to said shaft in a plane at right angles to its axis, a slide movable in guides on said plate and at like right angles to said shaft, an excentric attached to or made a part of said slide and so as to move with it, a pair of levers hung to said plate to swing in a plane parallel therewith, one arm of each lever weighted and free, the other arm arranged to bear upon said slide, and a spring to resist the movement of said slide under the outward swinging movement of the weighted arms, substantially as described. (2) The combination of the shaft of the engine, a plate or disc made fast to said shaft in a plane at right angles to its axis, a slide movable in guides on said plate and at like right angles to said shaft, an excentric attached to or made a part of said slide and so as to move with it, a pair of levers hung to said plate to swing in a plane parallel therewith, one arm of each lever weighted and free, the other arm arranged to bear upon said slide, a spring to

310,363.

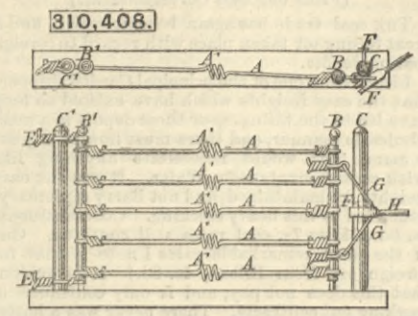


resist the movement of said slide under the outward swinging movement of the weighted arm, and an auxiliary spring in adjustable connection with said slide, substantially as described. (3) The combination of the shaft A, the disc or plate E, fixed thereto and in a plane at right angles to the shaft, carrying guides *a a*, the slide D, arranged and movable in said guides, the excentric B, attached to or made a part of said slide, a pair of levers hung to said plate and so as to swing in a plane parallel therewith, the longer arm G, provided with a weight at its outer end, the shorter arm I, turned inward to bear upon one end of said slide, and a spring arranged to resist the movement of the slide under the outward throw of the weighted end of the arm, said slide constructed with a slot to permit its movement in guides at right angles to the shaft, that end of the slide opposite the end upon which the shorter arms of the lever bear made heavier and so as to form a counterbalancing weight, substantially as described.

310,408. GATE, *Gideon Gibson, Union Township, Union County, Iowa.—Filed January 28th*, 1884.

Claim.—(1) In a gate, the wires A, having spring coils A^1, in combination with the frame pieces B B^1, the tie wires or hinges E, and the post C^1, substantially as specified, for the purpose set forth. (2) The latch lever H, having an open slotted end for engaging

310,408.

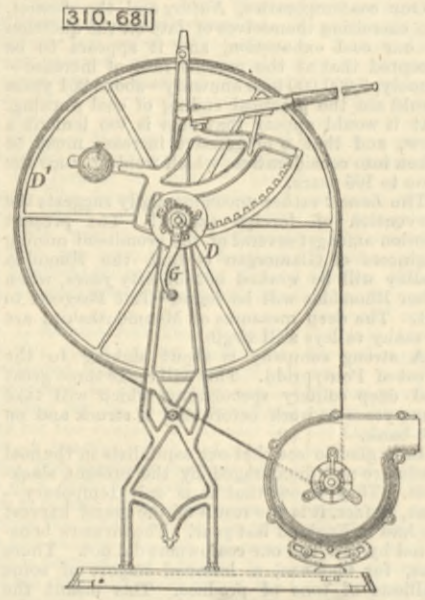


with the staples F F^1 on opposite sides of the post C, in combination with the gate frame and the connecting wire G, substantially as specified, and for the purpose set forth.

310,631. MECHANISM for OPERATING FAN BLOWERS, *John G. Hoffman, New York, and George Weber, Brooklyn.—Filed May 22nd*, 1884.

Claim.—(1) The combination, with the driving shaft and pulley or wheel, of a gear wheel or pinion loose on said shaft, and a rocking frame provided with a segment gear engaging with said gear wheel or pinion, a clutch connection between said gear wheel or pinion and shaft for turning the shaft in one direction only, and bearings for said shaft capable of adjustment to adapt said gear wheel or pinion to said segment gear, substantially as herein described. (2) The combination, with the driving shaft and its pulley or wheel, of a gear wheel or pinion loose on the shaft, a rocking frame provided with a segment gear engaging with said wheel or pinion, said gear or pinion and segment being provided with smooth

310,681

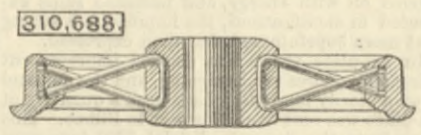


adjacent bearing surfaces, and a clutch connection between said gear-wheel or pinion and said shaft for rotating said shaft in one direction only, substantially as herein described. (3) The combination, with the driving shaft and pulley or wheel thereon, of a rocking frame and hand lever, and devices, substantially such as described, for rotating said shaft, an internally ratchet-toothed wheel upon said shaft, and a hand crank depending from said shaft and having a pawl capable of engagement with said internally toothed ratchet wheel, substantially as herein set forth. (4) The combination of the shaft D and pulley D^1, and a wheel fast on said shaft and provided with the internal ratchet teeth d^1, and the gravity crank G, and gravity pawl ^{5}, substantially as herein described.

310,688. CAR WHEEL, *Joseph G. Lafontaine, Champlain, N.J.—Filed September 15th*, 1884.

Claim.—In a car wheel, the combination of the chilled cast iron rim inclosing a wrought iron band

310,688.

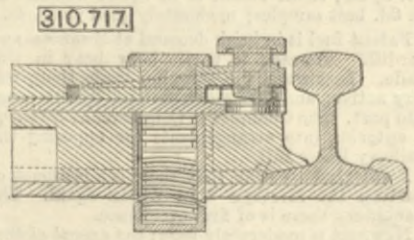


with the crossed wrought iron spokes and cast metal hub, substantially as specified.

310,717. TORPEDO RAILWAY SIGNAL, *Timothy G. Palmer, Schultzville, N.Y.—Filed January 21st*, 1884.

Brief.—The torpedoes, fed up by a spring from a magazine in the base block attached to the rail, are received one by one in the jaws of a sliding piece and carried forward over an anvil beneath a hammer placed in the path of the wheel tread and backward out of the way of the hammer as a switch with which it is connected is shifted, the sliding piece carrying the same torpedo until exploded. As the sliding piece reciprocates, cams thereon, acting upon a lever which is arranged above the sliding piece and engages lugs on the hammer, raise and lower the hammer. A removable cover is provided, through a capped opening in which the magazine may be charged. *Claim.*—

310,717.

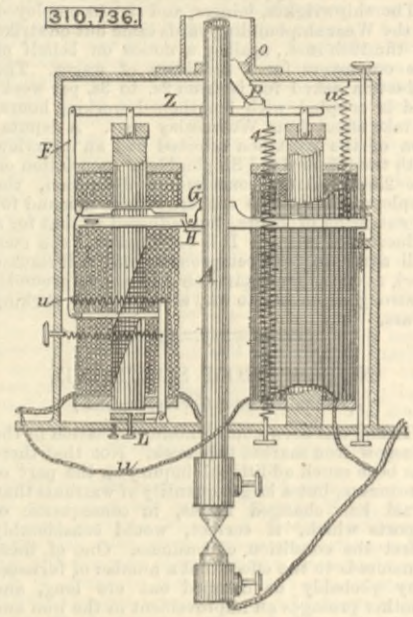


(1) The combination, in a danger signal, of an anvil upon which the torpedo can be exploded, a slide to move the torpedo, an exploder, a cap for holding the same, and a cam lever acted upon by the slide for raising the exploder before passing the torpedo under it, substantially as specified. (2) The combination, in a slide connected with a switch or other moving device, a torpedo holder placed below the slide and below the level of the track, an anvil, an exploder, a cap to hold the exploder and to cover the slide, and a lever or cam between the slide and the exploder to raise the exploder before passing the torpedo beneath it, substantially as specified. (3) The slide receiving an endwise movement and having a jaw for receiving the torpedo, in combination with an anvil upon which the torpedo rests, an exploder, a lever receiving its motion from the slide and by which the exploder is raised or lowered, and a cap covering the slide, substantially as specified. (4) The combination, with an anvil, of a torpedo magazine below the anvil, a spring to raise the torpedo, a slide for receiving such torpedoes, an exploder, a cap covering the slide and provided with an opening for the insertion of the torpedoes, and a cover for such opening, substantially as specified.

310,736. ELECTRIC ARC LAMP, *Sidney H. Short, Denver, Colo.—Filed January 31st*, 1884.

Claim.—(1) In combination, with the coils of an electric arc lamp, the fixed and movable cores formed with inclined faces, which faces are in planes parallel with each other, as set forth. (2) In an electric arc lamp, and in combination, coils of larger and smaller wire, as described, cores suspended from a lever, a clamp connected to said lever to raise the upper carbon holder, and gripping mechanism, substantially as described, adapted to drop the said carbon when the arc is unduly increased. (3) In combination, substantially as described, the coils of larger and smaller wire, the suspended cores, the pivotted lever Z, carrying a clamp adapted to raise the upper carbon holder, the rod F, lever H, clamp lever G, mechanism for turning rod F into and out of connection with lever H, springs for the levers Z and H, and means for limiting the movements of lever H. (4) A lever pivotted in the manner represented, in combination with the movable cores, wedge, ring, and rod F, substantially as and for the purpose set forth. (5) In combination with the carbon holder A, the

310,736.



lever Z, and suspended cores of the electro-magnets, one having smaller and the other larger wires, as described, and with a spring 4, the ring O and the wedge P, pivotted on the lever Z, and projecting upward against the carbon holder, all substantially as described. (6) In combination with the rod F and the lever Z, the lever H, spring U, adjusting screws, and the clamping lever G, the lever K, and armature L, and the spring and link connection of the lever K, all substantially as described. (7) In combination with electro-magnets having coils of wire of different size, a lever connected to the movable cores, and means thereon for separating the carbons, a gripping lever for lowering the upper carbon, a catch rod for operating the grip of the lowering lever, and an armature L, opposite the fixed core of the electro-magnet, having the larger wire, and connections between said magnet and the catch bar, all substantially as described.

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SOUTH KENSINGTON MUSEUM.—Visitors during the week ending Feb. 21st, 1885:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 11,134; mercantile marine, Indian section, and other collections, 2709. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 4 p.m., Museum, 1539; mercantile marine, Indian section, and other collections, 203. Total, 15,385. Average of corresponding week in former years, 14,369, Total from the opening of the Museum, 23,757,118.