ADMIRALTY COEFFICIENTS.

By ROBERT MANSEL.

THE paper on "Atlantic Steamers," by Mr. John, as published in THE ENGINEER of August 13th, contains some valuable data, which may be referred to in illustration of some parts of my recent papers on the above-mentioned interesting topic.

In my communication of 21st May, page 317, it is explained. The manner in which we may calculate the value of C, the Admiralty coefficient for an assumed speed V of a vessel, when the values, specific to that vessel, of two constant quantities a and c are known; the relation existing between them, and the speed of the vessel, being expressed by the equation,

$$\text{Log. C} = \text{log. } c + 2 \text{ log. V} - a\text{V} \quad . \; . \; . \; . \; . \quad (1)$$

I gave, in illustration, the data of H.M.S. Shah, for which $a = \cdot 0792$ and $c = 14\cdot 5$, the results for trial speeds,

	16·45	12·13	8·01	5·32 knots,

being as follows:—

Formula values of C =	195·4	233·5	215·9	155·5
Trial data values =	194·9	233·1	218·0	155·3

Results, I think, sufficiently close to indicate that the hypothesis embodied in (1) must be in fair agreement with the facts which it represents, and, as the sequel will show, is capable of being made even closer.

Let us now apply the same method to the vessels City of Rome and Normandie, of which Mr. John has supplied the values of C for a number of speeds.

For the City of Rome the values of a and c seem to be ·079 and 21·15 respectively.

Hence, trial speeds	18·235	16·0	15·0	14·0 knots
Formula values of C =	254·9	295·4	310·7	324·6
Mr. John's figures =	255	297·6	310·0	322·2

For the Normandie the values of a and c are $a = \cdot 079$ and $c = 20\cdot 0$.

Hence, trial speeds	16·66	16·0	15·0	14·0 knots
Formula values of C =	268·1	279·4	293·9	307·1
Mr. Johns' figures =	265·0	282·8	295·2	304·8

In these examples, the differences are within the limits of, and are such as might be expected as due to mere errors of observation. Mr. Johns' figures apparently have been taken from a curve of coefficients, not by actual observation at the speeds 16·0, 15·0, and 14·0 knots. This may account for great part of the discrepancies between the formula and trial data values. Again, these being all very large vessels, let us now consider the case of a small one, for which purpose let me refer your readers to THE ENGINEER of 14th January, 1881, where they will find the trial data of a torpedo boat distinguished by the letter "B," of which the displacement is given as 32 tons. For the lesser speeds of this vessel up to 16·4 knots the values of a and c are ·082 and 11·02 respectively; and hence by the formula log. C = log. 11·02 + 2 log. V − ·082 V we obtain:

For trial speeds	16·4	15·8	14·5 knots	
Formula values of C =	134·0	139·3	149·9, whilst directly calculated,	
From trial data C =	133·9	139·6	149·9	

Here, for the lower speeds, the agreement is nigh perfect, and the remarkable point to be noticed is, that with speeds 16·4 knots and greater, there is an entire and most obvious change in the values of the hitherto constant quantities a and c. Thus, instead of ·082 and 11·02, these quantities will then present the very much smaller values ·0182 and ·9875 respectively.

This most remarkable phenomena in steamship propulsion has been brought forward by me in a variety of shapes without eliciting recognition or comment, beyond some misrepresentation founded on obvious and utter misapprehension of the significance and value of the facts noted. To illustrate this last case fully, I append the calculation. The formula being log. C = log. ·9875 + 2 log. V − ·0182 V, we obtain:

For trial speeds		21·5	20·65	19 35	18·0	16·4 knots
Log. ·9875	=	−1·9945	−1·9945	−1 9945	−1 9945	−1·9945
2 log. V	=	2·6648	2·6298	2·5734	2·5106	2·4296
− ·0182 V	=	·3913	·3758	·3522	·3276	·2985
Sum	=	2·2681	2·2485	2·2157	2·1775	2·1256
∴ C	=	185·4	177·2	164·3	150·5	133·5

Next, the calculation of $C = \dfrac{D^{\frac{2}{3}} V^3}{E}$, from the trial data values, is as follows:—

Log. V	=	1·3324	1·3149	1·2867	1·2553	1·2148
∴ Log. V^3	=	3·9972	3·9447	3·8601	3·7659	3·6444
Log. $D^{\frac{2}{3}}$	=	1·0035	1·0035	1·0035	1·0035	1·0035
Subtract Log. E	=	2·7324	2·6950	2·6415	2·5911	2·5211
Log. C	=	2·2683	2·2492	2·2221	2·1783	2·1268
∴ C	=	185·5	177·5	166·8	150·8	133·9

The agreement of the values thus obtained, by very dissimilar formulæ, is so striking that I think it unnecessary to adduce further illustration; and, for better contrast, collecting these various results, we see that within limits of experience we have:

Shah	5,922	tons displacement		Log. C	= 1·1614 + 2 log. V − ·0792 V
City of Rome	11,230	,,		,,	= 1·3252 + 2 log. V − ·079 V
Normandie	6,959	,,		,,	= 1·3010 + 2 log. V − ·079 V
"B"	32	,,	to 16·4 knots	,,	= 1·0422 + 2 log. V − ·082 V
"B"	32	,,	above 16·4 knots	,,	= − ·0055 + 2 log. V − ·0182 V

Notice in this, as illustrated by the vessel B, the great fall in the same vessel of the values of the quantities a and c when driven over a considerable range of speeds; also another interesting fact with such vessels—three sets of values can be demonstrated, although in the ordinary run of vessels there are only indications of two sets.

The foregoing formulæ being represented in general terms, algebraically, by

$$C = \frac{c\,V^2}{\text{log.}^{-1}\, a\,V} = \frac{D^{\frac{2}{3}} V^3}{E},$$

obviously, from the second and third members, when in the form for logarithmic calculation, we may write:

$$\text{Log } D^{\frac{2}{3}} = \text{log. } c + \text{log. E} - (\text{log. V} + a\,\text{V}) \quad . \quad (2)$$

This formula may be applied to calculate the approximate proportional value of the hull dimensions element of the resistance; which, by hypothesis, is taken as the square of the lineal dimension; and as usually, and indifferently, may be represented by the immerged mid area, the two-third power of the displacement, or by the immerged surface. In the above form it is useful to detect changes in the circumstances of trial, or it may be the occurrence of undetected errors of observation in those trials. Take, for example, the Shah, where log. c = 1·1614 and a = ·0792:

Trial speeds		16·45	12·13	8·01	5·32	7 98 ?
Log. c	=	1·1614	1·1614	1·1614	1·1614	1·1614
Log. E	=	3·8737	3·3990	2·8876	2·5024	2 8876
− Log. V	=	1·2162	1·0838	0 9036	·7259	·9020
− a V	=	1·3029	·9607	·6344	·4214	·6320
Sum, log. $D^{\frac{2}{3}}$	=	2·5160	2 51:9	2·5110	2·5165	2·5150

Here, three out of four trial speeds show practically the same value, but with the third, if the speed was 8·01 knots with the stated power, the resistance must have been diminished in the ratio of the numbers corresponding to the logs. 2·5160 and 2·5110. It is therefore very much more likely that the speed has been slightly overstated, and ought to have been given as 7·98 knots; when, as shown in the last column, this gives D = 5922 tons, its actual value in the Shah (thus $\frac{2}{3}$ log. 5922 = 2·5150). To confirm this: we may return to formula (1), and with 7·98 instead of 8·01, calculate the value of log. C; we would find this comes out 215·5, while by the formula $\dfrac{D^{\frac{2}{3}}\ V^3}{E}$, 215·6 is the value, which is much closer than the values 215·9 and 218·0, as given by these formulas, when V is taken as 8·01. Another example: take the high speeds of "B," for which A = ·0182 and c = − ·0055:

Trial speeds		21·5	20·65	19·35	18·0	19·2 ?
Log. c	=	·0055	·0055	0055	·0055	·0055
Log. V	=	1·3324	1·3149	1·2867	1·2553	1·2833
a V	=	3913	3758	3522	3276	3494
Sum (subtract from)	=	1·7292	1·6962	1·6444	1·5884	1·6382
Log. E	=	2·7324	2 6990	2·6415	2·5911	2·6415
Log. $D^{\frac{2}{3}}$		1 0032	1·0028	·9971	1·0027	1·0033

Here, again, as given, the third speed 19·35 is very probably erroneous, and ought to be 19·2. Thus, in the last column, the figure came out 1·0033, which is exactly $\frac{2}{3}$ log. 32, indicating the exact displacement. Whilst if we recur to formula (1), and with the value V = 19·2, calculate the value of log. C, we find it gives C = 162·8, and by the trial data C = 162·9; whilst V = 19·35 gave these values as 164·3 and 166·8 respectively, a further proof of the exceedingly definite and sensitive nature of these formulæ, and the certainty with which they indicate the slightest incongruity in the data. The Admiralty formulæ, were they true to the mechanical principles which they involve, ought not only to be a measure of comparative efficiency, but also satisfy another definite and obvious test; when we had tried the same vessel, under the same circumstances, at different speeds; as we are only doing work of a like kind, in this case, the efficiency ought to be the same; and necessarily, the Admiralty coefficients ought to have the same value. This is certainly quite contrary to all experience of the numbers obtained and usually designated Admiralty coefficients; and the reason is all investigations and proposed formulæ, from before the investigations of M. Réech down to that of Mr. John, have proceeded on the erroneous assumption that the velocity element of the resistance varied as the square of this velocity. Now, for about thirty years back, I have been demonstrating *ad nauseam* that it is not so, quite otherwise than so; this quantity being a transcendental function expressed by the notation, $10^{a\,V} = \text{log.}^{-1}\, a\,V$—that is to say, as the number, of which the common logarithm is the speed multiplied by certain small quantities which are represented in these expressions by the letter a, and of which, I have given sundry explanations. No better or more trustworthy illustrations can be given than those offered by the Admiralty trial data, to which I have often referred, and here repeat one of the most striking—the trials of H.M.S. Shah.

Trial Data of H.M.S. Shah.

No. of trial.	Gross indicated horse-power.	Speed in knots.	Value of $C = \dfrac{D^{\frac{2}{3}} V^3}{E}$.	Value of $c = \dfrac{D^{\frac{2}{3}} V \text{ log.}^{-1} \cdot 0792\,V}{E}$.
(5)	7477	16·45	194·9	14·47
(6)	2506	12·13	233·1	14·48
(7)	772	8·01	2:8·0	14·64
(8)	318	5·32	155·3	14·46

Here the last column shows the real value of the Admiralty coefficient for the Shah, obtained by multiplying the number in the preceding column by the fraction $\dfrac{\text{log.}^{-1}\cdot 0792\ V}{V^2}$, which is simply, to replace the faulty hypothetical quantity V^2, by the very approximate true value log.$^{-1}$ ·0792 V. It will be observed experiment (7) gives the value of c slightly greater than the other three; but I have already pointed out by two different methods that the given speed 8·01 is slightly overstated; it ought to be 7·98 knots, and if this be taken as the value of V, the value of c is 14·50, and then we are justified in asserting that the real value of this quantity for the Shah, taking an average, is 14·48; that is to say, we have, for the relation of power and speed, in H.M.S. Shah, the equation, $E = \dfrac{D^{\frac{2}{3}}\,V}{14\cdot 48} \text{ log.}^{-1}\ \cdot 0792\ V.$

The agreement is so singularly close that a little space may be usefully employed in illustrating it:—

Trial speeds		16·45	12·13	7·98	5·32	
Log. $D^{\frac{2}{3}}$	=	2·5150	2·5150	2·5150	2·5150	
Log. V	=	1·2162	1 0839	·9020	·7259	
·0792 V	=	1·3028	·9607	·6320	·4213	
Subtract Log. 14·48	=	1·1608	1·1608	1·1608	1·1608	
Sum, Log. E	=	3 0732	3·3988	2·8882	2·5014	
∴ E	=	7468	2505	773	317	indicated horses.
By trial data	=	7477	2506	772	318	,, ,,

The variety of values of C given by the usual formulæ are absurd, and show these formulæ to be founded upon false assumptions. Mr. Johns' proposal to make them comparative, by dividing each set by the square of one-tenth the length of the bow—that is to say, by a constant divisor for each set—does not, in the slightest degree, reach the source of error in these quantities. We must first remove the variations in the values given by the different speeds, in the same vessel, before we can have true comparative numbers for different vessels. This proposition may be thought over with some advantage. I shall add no more at present. ROBERT MANSEL.

White Inch, Glasgow, August 25th, 1886.

CANALS AS A MEANS OF TRANSPORT.

AT a time when the British manufacturer is finding himself hard pressed by foreign competition, and when it is thus of the utmost importance that every item of cost should be reduced to the minimum, it is not unnatural that more than usual attention should be directed to the question of cheap transport. It is scarcely disputed that in this country the railways generally are accustomed to charge higher rates of freight than are paid in countries that have become our most formidable competitors in neutral markets; but the answer of the railway companies is that the expense of construction in England is higher than elsewhere, and that it is necessary to provide for this fact in the cost of transport. Failing to obtain the concessions they require from the railways, the traders are now seeking to restore the canals to such a condition of efficiency as will enable them to offer competing routes and lower rates of freight. This consideration has been strongly urged in several communications made by trade associations to the Royal Commission on Trade Depression, and it has been insisted on at the recent general meeting of the Association of Chambers of Commerce. Under these circumstances, it is opportune to review the condition of our internal waterways, and the prospects that lie before them.

There are now in the United Kingdom 3931 miles of canal navigation, of which 927 miles belong to public trusts, 1445 miles to independent companies, 1333 miles are guaranteed and owned by railway companies, 188½ miles are derelict, and 37 miles belong to owners of whom nothing appears to be known. It will thus be seen that 34 per cent. of all the canal mileage in the country is in the hands of the railway companies. The chief among the canal-owning railways is the London and North-Western, which has eight different canals, having a total length of 488½ miles. Among these, the two principal, alike in respect of their length, and the districts which they traverse, are the Birmingham canals, with a total of 169 miles, and the Shropshire Union Canal, with a length of 203 miles. These canals pass through very important districts, and should, if they were allowed fair play, prove a very formidable rival to the railway system of which they may be said to form a part. The first will admit craft of 72ft. by 7ft., and the second is adapted for vessels of 80ft. by 15ft. The Midland Railway is not much of a sinner in regard to canal traffic, possessing, as it does, only the Ashby-de-la-Zouche and the Oakham canals, the latter of which has been converted into a railway. It is, however, otherwise with the Great Western Railway, which owns 257½ miles of canals, the two principal of which are the Kennet and Avon, 85 miles in length, and the Monmouthshire, Breckon, and Abergavenny, 54 miles in length. The former canal is distinguished for the large size of craft that it can provide for, occupying in this respect the fourth position among the canals of England, as the following figures show:—

The Severn Trust Canal will admit craft	270ft.	by 35ft.
The Aire and Calder ,, ,, ,,	212ft.	by 22ft.
The Gloucester and Birmingham ,,	163ft.	by 29ft.
The Kennet and Avon ,, ,, ,,	120ft.	by 18ft.

The Great Western Railway Company has converted into a railway the Hereford and Gloucester Canal, thirty-four miles in length, which probably did not traverse a district of the first industrial importance; but all the same, the alternative route for heavy traffic was calculated to be a real public benefit. Several important canals are owned by the Manchester, Sheffield, and Lincolnshire Railway, including the Chesterfield, forty-six miles in length, and the Dunn Navigations, thirty nine miles long. The total length of the canals owned by this company is 180½ miles, and 104½ miles more are owned by the Great Northern Railway Company, the principal two being the Grantham, 33½ miles, and the Witham Navigation, 31 miles long. Canals of minor extent are also owned by the Lancashire and Yorkshire, the North-Eastern, the North Staffordshire, and the Great Eastern Railway Companies. Most of the canals so owned are scarcely worked at all, no provision being made, as a general rule, for allowing the public the choice of such an alternative method of transport. It is, of course, quite a different matter with canals owned by public trusts and independent companies. These unitedly own or control 2372 miles of canal navigation in England and Wales, which is 1039 miles more than the extent of navigation owned by the railway companies. It cannot, therefore, be truly said, as it is in many quarters believed, that the railways have a controlling interest in the canals of the country. Nor is it so true, as is largely believed, that traders are without alternative routes in the form of water transport. The fact is that few industrial centres are without canals that may be resorted to for, at any rate, local traffic, while many give access to the larger markets of the country. In Lancashire, for example, there is, among canals of importance, the Duke of Bridgwater's, the Irwell Navigation, the Rochdale, and the Leeds and Liverpool; in Staffordshire and Worcestershire there is the Birmingham, the Stourbridge, the Warwick and Birmingham, and the Staffordshire and Worcestershire canals; in Yorkshire there is the Aire and Calder, the Leeds and Liverpool, and the Ouse river; in Leicestershire, the Leicester and the Leicester and Northampton canals; in Cheshire, the river Weaver, and the Droitwich canals; in Wales, the Aberdare and Glamorganshire canals; in Gloucestershire, the Avon, the Wye, and several smaller canals, not to speak of the Severn river; and so with other counties and districts. But it happens in only very few cases—as in that of the Leeds and Liverpool Canal—that these canals, all of which are controlled independently of railways, afford through communication from one important centre to another. They do not, as do the railways, form great trunk lines, by means of which goods can be transported direct from any one part of the kingdom to any other; and they also labour under the serious disadvantage, in practical operation, of lack of uniformity of dimensions, rates, and general control. Some of them will allow of the passage of vessels over 200ft. long, while others will only pass craft of 50ft. to 55ft. It would be possible to remedy this condition of things if the canals were not under so many separate and conflicting jurisdictions, and especially if the railway canals were made as free as all the others. As it is, about 120 miles of canal navigation have been converted into railways, and 188 miles have become derelict or abandoned, presumably in consequence of their failure to remunerate their owners for the cost of maintenance. Most of the existing waterways are in a more or less neglected state. The advent of the railway system was in many quarters believed to seal the doom of the system of transport which it superseded; and as the traffic became more and more diverted from the canals, they were permitted to get into a worse and still worse condition. At the present juncture, therefore, it would perhaps not be too much to say that not one-half of the total canal mileage of the country is adapted for the requirements of trade without a very considerable expenditure in improvements and repairs.

In considering the subject of through canal routes between termini lying wide apart, it is obviously necessary that if several separate canals have to be traversed, they should each be, if not under the same control, at any rate equally well adapted for the traffic in view. This unfortunately, is not always, and perhaps not generally, the case, so that canal boats and barges are sometimes compelled, in passing through a canal that has not been properly administered to lighten their loads, in order to provide for the reduced draught available. An example of this kind was recently brought to the notice of the management of the Thames and Severn Canal.[1] It was represented that whilst ordinary canal boats, carrying 30 tons, could pass from the pit's mouth in Staffordshire through the Midland canals to the river Severn, and thence over the Gloucester, and Berkeley, and Stroudwater Canals to the Thames and Severn Canal, they were compelled, before passing through the latter, to discharge about one-half of their cargo, and had consequently to make two voyages instead of one. The delay and expense hence arising would not, of course, occur if the Thames and Severn Canal were put in a proper state of repair.

Outside of those whose business or professional occupations have led them to specially examine the subject, it is probably but little known how far inland water communication is already available between the large centres of production, consumption, and export or import in England and Wales. There are, to begin with, three separate routes of this description between London and Liverpool; but they are so complicated in their physical features, ownership, tolls, and other arrangements, as to be but little used. One of these routes starts from the Regent's Canal, and proceeds thence by the Grand Junction, the Oxford, the Warwick and Napton, the Warwick and Birmingham, the Birmingham, the Staffordshire and Worcestershire, and the Shropshire Unions canals, for a total distance of 235¾ miles, and thence again by the river Mersey for a further distance of ten miles, making up a total distance of 245¾ miles. A second route takes the Thames for twenty miles, the Grand Junction Canal for ninety-four miles, the Oxford Canal for twenty-four miles, and the Coventry Canal for twenty-seven miles, and proceeds thence by the Birmingham, North Staffordshire, and Duke of Bridgwater's canals until the river Mersey is again reached, fifteen miles from Liverpool, the total distance being 263½ miles. A third and somewhat longer route than either of the other two follows the same course as the second route for the first 114 miles, and then proceeds by the Oxford, the Warwick and Napton, the Warwick and Birmingham, the Birmingham, the Staffordshire and Worcestershire, the North Staffordshire, and the Duke of Bridgwater's canals to the Mersey, into which the same debouchment is made as in the second route. But in each of these cases it would be perfectly practicable for the navigation between the two greatest cities in the kingdom to be closed by the caprice or veto, for any purpose whatsoever, of railway companies, who in every case own or control one or other of the canals on the line of route. Between London and Hull there is inland navigation available the whole way by two separate routes, one of which is, and the other is not, controlled by railway companies. In the case of the route that is outside railway jurisdiction, the canals traversed are the Regent's, the Grand Junction, the Grand Union, the Leicester and Northampton, the Leicester and the Sour, after which the course lies *viâ* the rivers Trent and Humber, the total distance covered being 289 miles, as compared with a distance of 174½ miles by rail. The second route available proceeds *viâ* the Thames and the Grand Junction, Oxford, and Coventry canals, as in the case of the second route to Liverpool, until the North Staffordshire Canal is struck, and thence the route is again *viâ* the Trent and the Humber rivers; but in this second route the distance is thirty-four miles longer than in the case of the first. There are three separate canal routes available between Liverpool and Hull, two of which are beyond railway control. The simplest, if not the shortest, of the three routes, takes the Leeds and Liverpool Canal for the first 127 miles, and then proceeds by the Aire and Calder Canal until the river Ouse is reached, after traversing which for eight miles, the Humber is struck 18½ miles from the great Yorkshire port. The second independent route, after fifteen miles of open navigation in the Mersey, takes four several canals in their turn—the Duke of Bridgwater's, the Rochdale, the Calder and Hebble, and the Aire and Calder—and then follows the same course over the Ouse and the Humber, as in the first route spoken of. The third route, proceeding by Rochdale and Huddersfield, involves the use of the Huddersfield and Sir John Ramsden's canals, both of which are controlled by railway boards.

In the case of the most important inland manufacturing district in England—that of South Staffordshire and East Worcestershire, including Birmingham and Wolverhampton—there is a considerable choice of routes to the principal ports, besides that of the railway, a fact which seems to render the heavy railway rates that are charged by, and paid to, the railway companies somewhat difficult to explain. There is canal communication all the way from Birmingham to London *viâ* the Birmingham, Warwick, and Birmingham, Warwick, and Napton, Oxford, Grand Junction, and Regent's canals, the total distance covered by this route being 163½ miles, as compared with 113 miles by railway. Liverpool may be reached from the same district by two alternative canal routes, the first proceeding by the Birmingham, Staffordshire, and Worcestershire, and Shropshire Union canals, until the Mersey is reached, ten miles from the port; and the second, taking the same course as regards the Birmingham Canal, and then proceeding to the Mersey by the Staffordshire and Worcestershire, North Staffordshire, and Duke of Bridgwater's canals. The distance by the first route is 89¼ miles, and by the second, 106½ miles. There is, besides, through communication by inland navigation between South Staffordshire and Hull, and between the same district and the Severn ports. From all that has been stated, then, it must be tolerably evident that if only the inland water-ways of the kingdom were kept in good condition, and well-managed, they are already sufficient in point of extent to give traders alternative routes over a large area.

It is a somewhat remarkable fact that while Great Britain has been neglecting her internal water-ways, and while our traders have been content to depend upon railway transport almost exclusively, the French and some other nations of Continental Europe have been spending large sums of money in endeavouring to establish a complete system of canal transport between the chief industrial and commercial centres. A commission of the French Chamber of Deputies reported in 1879 that it was "impossible to fulfil the requirements of commerce and industry without the service both of railways and canals," and hence they recommended the completion of the network of canal water-ways in France by the expenditure of 11¾ millions sterling on the improvement of existing canals, and of 16½ millions on the construction of new ones, making a total of about 28½ millions sterling. In favour of this project, the Commission stated that while coal could not be carried on railways for less than 0·5d. to 0·6d. per ton per mile, it could be transported by canal at less than one-half the lowest of these rates. This has been much the experience of the canal system of Belgium, which has in consequence been carefully cultivated and largely extended. On the other hand, however, it must be said that there is certainly not much encouragement to be drawn by those who desire to see the canal navigation of the past restored to its pristine utility as a means of transport from the annals of the canal system of the United States. In that country there were in 1880—the most recent year for which returns are at command—a total of 4468 miles of canals, or about 136 miles more than the total canal mileage of England and Wales. But of these 4468 miles, no less than 1953 miles had been altogether abandoned, and it was reported that a large part of the remaining 2515 miles was not paying expenses. In the New England States all the canals had been abandoned. In New York State, 357 miles of canals, the construction of which had cost over 10¾ millions of dols., had been abandoned, as was also 447 miles in Pennsylvania, constructed at a cost of 12¾ millions of dols.; 205 miles in Ohio, constructed at a cost of 3 millions of dols.; and 379 miles in Indiana, costing 6¼ millions of dols. so recently as 1851. The total cost of the canals of the United States has been returned officially at 214 millions of dols., or about 53 millions sterling. The average cost per mile of canal built has been 48,000 dols., or about £9600, against an estimated average of £6560 for the canals in the United Kingdom, and an average of £6229 per mile for the French canals.

The two most important American canals, the Erie and the Champlain, are both in the State of New York. The former canal was constructed for the purpose of uniting the waters of Lake Erie and the Hudson. The total length of the canal, with its branches and feeders, is 365 miles, and the total cost was 51,609,000 dols., or upwards of £141,000 per mile. The width of the canal is 70ft. at the surface, and 52½ft. at the bottom, the depth being 7ft. There are seventy-two locks, each 110ft. in length by 18ft. in width, and having a rise and fall of 656ft. The total freight traffic on the Erie Canal in 1880 was 4,608,651 tons; the gross income, 1,120,691 dols.; and the net income, 442,567 dols.—which was only equal to paying about 1 per cent. on the capital cost of construction. The total expenditure incurred on behalf of the canal for the year in question, including cost of working, was 678,124 dols., or 60 per cent. of the gross income. In the case of the Champlain Canal the results are much less satisfactory still, the amount of freight moved in 1880 having been 1,200,000 tons; the gross income, 51,267 dols.; and the expenditure, 136,520 dols.; leaving a deficiency of 85,253 dols.

The experience furnished by the United States proves that, where the traffic is of a character to bear railroad carriage, assuming it to be a little higher than canal transit, the rail will generally be preferred, even in cases where there may be competing canal routes at lower rates. In proof of this we need only refer to the traffic returns of the New York State canals and of the railways that pass through or approach the same territory. In 1868 the New York State canals carried about 6½ millions of tons of traffic, at an average rate of ·872 cent (halfpenny) per ton per mile. In 1873 they carried 78,000 tons less, at an average of ·887 cent per ton per mile, being an increase of ·015 cent per ton per mile; and in 1883 the quantity of freight moved had fallen to a little over 5½ millions of tons; but the average ton-mile rate for that year does not appear to have been calculated. Now compare these figures with those that refer to the chief competing route—the New York Central Railroad. In 1886 the total traffic carried on that line was 1,846,000 tons, and the average ton-mile rate was 2·743 cents, or more than three times the amount of the average canal rate for the same year. Yet, in spite of this enormous difference, the railway traffic went on increasing until, in 1873, it amounted to 5,522,000 tons, being an increase of 3,676,000 tons, or about 200 per cent. on the quantity carried in 1868, notwithstanding the enormous difference in the cost of transport as against the railroad already referred to. In 1873 the average ton-mile rate on the New York Central had been reduced to 1·573 cents—a reduction of 1·170 cents, or about 43 per cent. on the average ton-mile rate of 1868. But even at the reduced rate, the railway was still charging ·686 cent, or about 77 per cent., more than the canals. It might be thought that this difference would tend to militate against the progress of the railway in the comparatively depressed times that followed. But so far from that being the case, the official figures show that between 1873 and 1883 the traffic on the New York Central had just about doubled, while on the canals of the same State there was, as we have already shown, a very considerable decline. The movement may be even more strikingly illustrated if we group in one table the average rates by canal and lake and by railroad alongside the total grain and flour traffic received at New York for the period 1878-1884, as set forth in the official report on the foreign commerce of the United States for 1884:—

Grain Traffic by Canal and Railway between Chicago and New York, and Average Rates per Bushel.

Year.	Grain and flour receipts at New York. By canal and river. (1=1000 bushels.)	By rail. (1=1000 bushels.)	Average rates per bushel. By canal. Cents.	By rail. Cents.
1878	63,905	85,350	9·15	17·7
1879	57,044	101,116	11·60	17·3
1880	69,440	95,414	12·27	19·7
1881	38,192	98,574	8·19	14·4
1882	34,631	81,224	7·89	14·6
1883	44,946	81,636	8·40	16·5
1884	—	—	6·60	13·0

These figures make clear the fact that, notwithstanding an average difference of nearly 100 per cent. against the rail in the matter of freight, that system of transport has made relatively greater progress than that by the lake, canal, and Hudson River route. There is not, in this case, any obvious reason why such a result should happen. The traffic carried by the water highways was by no means in excess of their capacity to forward, and therefore the objection that might be supposed to attach to the condition of things so notorious on the Suez Canal cannot apply. The truth of the matter appears to be that on the water-ways traffic is carried much more slowly, and freighters appear to think it worth while paying higher rates to secure greater despatch. Another serious objection attaches to the use of canals, and has greatly hindered their more general adoption in the United States. All inland water-ways are liable to be seriously affected by weather—by drought in summer and by frost in winter. Both are alike detrimental in their several ways, and so thoroughly is this recognised in America that there is a specific season for inland navigation, viz., from May to November. Now it is hardly to be expected that freighters will give themselves much trouble in a general way about a means of communication that is so precarious and uncertain, when they have at command a rival system that is always entirely to be depended upon; nor can it be expected that those who find themselves compelled to use the railway in winter will undertake the trouble of looking into the subject of canal organisation, rates, facilities, and so forth, when the rail secures all they require so much more swiftly and surely all the year round. It is also to be remembered that canal rates are generally subject to a small additional payment for marine insurance, generally about ½ per cent. Still, after every consideration has been taken into account, water transport remains much the cheaper of the two. This fact is so obvious and so generally admitted that it scarcely needs to be insisted on. The greatest advantage possessed by canals next to that of their lower first cost is the much lower expenditure in working and maintenance than belong to railways. Mr. Conder has calculated that out of every £200 paid for an equal tonnage transported an equal distance the detailed costs are:—

Item.	By railway.	By canal.
Maintenance of way	£13	£0·
Maintenance of works	7	2·3
Repairs of rolling stock	19	6
Traction	16	8
Traffic expenses	30	6
General charges	15	15
Interest on capital	100	33·3
Total	£200	£70·6

On these and other data of a cognate character it has been calculated that while the cost of an equal amount of traffic on the railways and canals of the United Kingdom would be 1·21d. per ton per mile in the case of the former, it would only be 0·37d. per ton per mile in that of the latter. In other words, canal transport is little more than a fourth that of railway transport for the same volume of trade. If the substantial accuracy of this estimate were to be assumed, it would seem to follow that if canals are made to take the place of railways as regards mineral traffic generally, the cost of transporting such traffic, which now amounts to about sixteen millions sterling per annum, might be reduced to little more than four millions, which would leave a balance of about twelve millions, now paid for railway transport, either to be disposed of in favour of the general public, as consumers, or to help to provide that margin of profit for coalowners and ironmasters to which they have now for some years been strangers. Whatever limitations may require to be placed on these figures—and it is not to be pretended that they are absolutely exact—they are sufficient to show that the utilisation of our internal waterways for heavy and slow traffic is a matter of sufficient importance to justify the attention it has recently been, and is still, receiving from the commercial world.

[1] Report by Messrs. Clegram, H. J. Martin, and Snape, dated 4th January, 1883, on the Thames and Severn Canal.

VISITS IN THE PROVINCES.

THE METROPOLITAN RAILWAY CARRIAGE AND WAGON WORKS, BIRMINGHAM.

THESE works, celebrated for the high-class railway carriages which they turn out, originated in the old coaching days, when Messrs. Joseph Wright and Sons made stage coaches in London, and also ran them to some of the main provincial centres. When, however, the railway began to supersede the road for the principal means of communication, Joseph Wright, wise in his generation, began to make the new rolling stock—rather more primitive, as we know, than the composite carriage for the Great Northern Railway that his lineal successors are now showing at the Exhibition in Bingley Hall, Birmingham. The works were then transferred to their present site at Saltley, and in 1861 the business was made over to the present limited company.

The works occupy an area of about fifteen acres, of which nine are covered by shops. The two large finishing and paint shops, provided with traversers, have eleven roads, and are capable of accommodating fifty or sixty vehicles at once. Formerly the great difficulty was to keep this department from being choked up; but now, unfortunately, it is more than half empty, the most prominent features being some large tramcars with roof seats for the North London Tramways, and some Liliputian stock for a 2ft. light railway in Western Australia. While, of late years, the company has kept up to 1400 men fully employed, it has now only half that number. Though feeling the keen competition previously, it has only been during the present year that it has been short of work.

A 2ft. gauge tramway connects all the shops, and the works are served by the ramifications of a siding in connection with the Midland Railway, by which timber is principally brought. The logs on trucks are hauled up an incline by power and placed on a saw bed, when a circular saw is fed up to them by an endless screw, cutting the ends off square. They are then sawn longitudinally in one of two old, but excellent, reciprocating saw frames, made by Horne, of London. The planks thus formed for a wagon or carriage frame are placed on a bed provided with rollers, extending the whole length of the shop, in front of three machines, of which the first bores the holes, the second saws off both ends to dead lengths and forms the tenon, and the third slots out the mortice. Of all the woods, teak is preferred, especially for India, as it best resists the ravages of white ants.

For saving time in marking off, and for getting the holes perfectly true as regards their position, an iron template is laid over the plank to form the frame; and a centre punch, exactly fitting the holes already drilled in the template, makes a centre mark for receiving the point of the auger bit. The same system is employed for iron and steel frame plates; but in their case the iron template is provided with a series of chilled steel bushes, through which the drills pass, thus securing perfect truth and interchangeability. Indeed, to such a high pitch is the quality of iron and steel work for carriages now brought, that it really equals that for locomotives, while, as the works' manager bitterly complains, it is only paid for at carriage price.

Whereas formerly it was the usual practice to fit the iron headstock or buffer beam to the sole bar or side frame by butting one of them against the other, a neater and better job is now made by paring away the flanges of one, or portions of their thickness, so that the web of one forms a kind of tongue which fits into the channel of the other. At first this was done by hand, with hammer and chisel; but now the flanges are pared away in a machine having four discs set with cutters which work on the top and bottom of both ends of the channel at once. The holes in the channel irons are drilled in a multiple drilling machine, the drill heads of which have worm wheels driven by a horizontal endless screw revolving above them.

Although triple lathes are not new, having been made by Messrs. Tangye for some time, that designed and used at the Saltley Works is worthy of notice for the simple arrangement of its gear. The three headstocks, in horizontal planes, are provided with worm wheels and rotated by a worm revolving underneath them. The slide rest carries three tools, so that the depth of cut, and also the pitch of screws, is uniform—another instance of securing perfect interchangeability of parts. During our visit this lathe was engaged upon the right and left-handed screws for couplings, which it turned out in great perfection, not only as regards exactitude, but also a sufficiently high finish. In these works all the shafting is underground, so as not to interfere with working the machines.

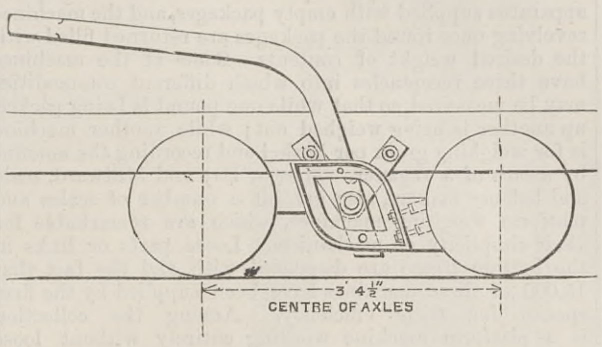
All the work, except occasionally wheels and axles, is done "at home." Small wrought iron parts are, of course, stamped as far as possible. The class of steam-hammer found most handy for general purposes is the light single-standard double-acting hammer, one of which the works' manager would like to see between each pair of smiths' fires. One of the most delicate jobs in smithing is welding the head on to the hollow cylindrical part of a buffer plunger, as it requires great experience to get the required "short" heat, and then considerable smartness in effecting the weld, which is done under the steam-hammer.

Besides the work already mentioned, the company has in the shops 133 wagons and carriages for the Nizam guaranteed line of the Indian State Railways, with frames partly of steel and partly of iron. The frames of some stock for the Bombay and Baroda Railway are composed of a very fine section of steel channel bars, rolled at Ebbw Vale. Steel, indeed, is gradually superseding iron in the construction of rolling stock, the saving in dead weight for a given strength being very appreciable. The general manager of the Saltley Works is Mr. John Rawlins, who, in courteously desiring the works' manager to place every infomation at our disposal, made scarcely any restriction.

BROWN, MARSHALL, AND CO.'S WORKS.

These railway carriage and wagon works were started by Messrs. Brown and Marshall, at Birmingham, in 1844, and being cramped for room, were transferred to Saltley in 1858, the firm becoming "limited" in 1870, with Sir James Allport as chairman of the Board of Directors, and Mr. Arthur L. Shacklefold as general manager. The works now occupy eleven acres, of which about nine are covered by shops. When in full work they employ a thousand men; and even now there are nine hundred engaged, because the company builds extensively for South America, and there is now a great deal of work for that quarter. There are now in the shops some hotel cars of Russian type for Buenos Ayres, two of them forming a complete residence for a gentleman and party touring for weeks together, with kitchen, dining-room, bedrooms, and every possible convenience, the whole fitted up in the most luxurious style.

In some side-tipping wagons that are being made for the Tharsis Sulphur and Copper Company the wheel base is so short that an ordinary brake gear could hardly be got in between the wheels. Accordingly the arrangement shown in the annexed cut is adopted. The frame carrying the



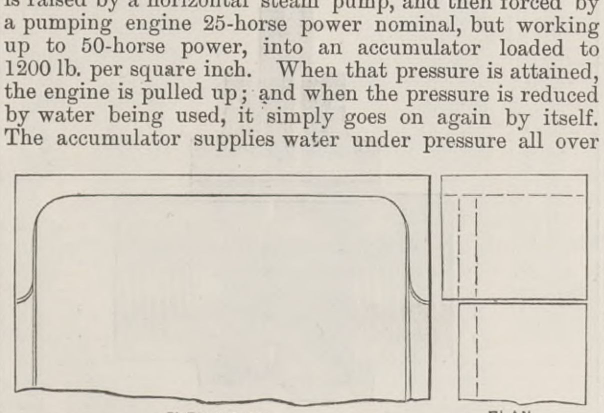
WAGON BRAKE GEAR.

cast iron brake blocks, which bear only on their outside edges, is made of 3in. by 3in. by ½in. angle irons welded at the mitres. Pressure upon the lever pinned to it brings the blocks against the periphery of the wheels.

The works are illuminated throughout by the electric light, the plant for which the company has, through special circumstances, acquired on such advantageous terms that the lighting compares very favourably with that by gas, both as regards cost and efficiency. There are forty 2000-candle arc lamps maintained by a Brush dynamo, with a 6 arc ditto for lighting the forge separately from the other shops in case of need, and also a hundred and twenty 20-candle incandescent lamps, maintained by a Ferranti dynamo. All the dynamos, in a building to themselves, are driven by a 25-horse power nominal Fowler semi-portable engine with steel boiler and tubes. The expansion gear is controlled by one of Fowler's double-action governors that is reported to leave absolutely nothing to be desired in point of regularity.

The Festiniog Railway was made by this company, which laid down a piece of the way for testing at the works, and was so satisfied with it that it has laid the same way—2ft. gauge throughout the works, which are connected by a siding with the London and North-Western system. Although there is still one heating furnace with a vertical boiler surrounding the flue, this system is discarded because of the blow-pipe action of the two flues tending to burn out the lower plates. The waste heat from the remaining furnaces is utilised in horizontal boilers, which are more convenient and accessible for inspection. The steam hammers are by Messrs. Thwaites and Rigby, varying in power from 10 cwt. to two tons. Driving the fitting shop is an interesting relic in a 250-H.P. beam engine, built by the old firm of Brown, Marshall, and Co., in 1858, as a compound engine, but now used as a low-pressure engine. There is a special department for packing wagon ironwork to be sent abroad and fitted up on the spot.

About two hundred ordinary wagons may be put down at once in the frame shop—460ft. by 110ft.—probably the largest for the purpose, that was finished two years ago. It has been erected cheaply, with galvanised iron roof, and is provided with every appliance necessary for turning out the iron under frames of wagons and carriages. Water is raised by a horizontal steam pump, and then forced by a pumping engine 25-horse power nominal, but working up to 50-horse power, into an accumulator loaded to 1200 lb. per square inch. When that pressure is attained, the engine is pulled up; and when the pressure is reduced by water being used, it simply goes on again by itself. The accumulator supplies water under pressure all over



the shop for a 40-ton swivelling crane, especially intended for heavy bridge and girder work, and also for the Tweddell rivetters and the straightening machines. The latter, for straightening channel bars, are horizontal, and have three swivelling heads, two fixed and the third on the ram. All the other machines are driven by a vertical 8-horse power nominal engine, working up to 16 to 20-horse power, which works direct on to the fly-wheel fast on the main line shaft. The under frames made in this shop consist of iron or steel channel bars; and, as a rule, the headstock, or buffer beam, is arranged with the web outside, and the sole bars, or side frames, with it inside. In this case, also, the web of the sole bar is milled away, so as to leave a tongue fitting into the channel of the headstock, as shown in the sketch below. The sole bar is placed, web downwards, on the bed of a special machine, carrying two double milling cutters, which, while revolving, are gradually fed down by screws and gear, milling out both the flanges of both ends at once, and leaving the webs in dead lengths, with the ends in the form of a tongue which exactly fits the channel of the headstock. As this machine is now fully employed, the experiment is being made of drilling holes in the flanges, and then taking out in the punching machine the remainder of the part that has to be removed. At these works, also, all the drilling is done through in templates with chilled steel bushes, thus saving all marking off, and ensuring perfect accuracy and interchangeability.

In conclusion, we cannot but acknowledge the great courtesy of Mr. Shacklefold, who showed us unreservedly "how it's done."

MIDLAND RAILWAY CARRIAGE AND WAGON WORKS.

As Messrs. Brown, Marshall, and Co. have no foundry, they get their castings made by the Midland Railway Carriage and Wagon Company, whose Birmingham works are in close proximity. The latter are not included among the works to be visited by the British Association, probably because they are now only a subsidiary establishment, as the principal works of this company have been at Shrewsbury for the last seven or eight years. Still, their works at Birmingham, or rather Saltley, cover an area of 5½ acres, and employ 300 men on an average. The foundry cupolas are made out of old boiler flues, which serve admirably for the purpose when lined with firebrick, though, of course, they are not capable of such refinements as an air chamber or a reservoir for molten metal. Most of the wagon wheels are still made with a cast iron boss enclosing the ends of bar iron spokes. The bars are bent into the section of a circle, forming part of the rim and two half spokes, in a belt-driven horizontal machine made by Berry, of Sowerby Bridge. A powerful combined shearing and punching machine, also driven by belt, has an additional shear in the centre for cutting off bar or angle iron to lengths. In some hopper wagons for shipping ore in New South Wales, the inverted trunco-pyramidal body rests on brackets in the underframe, whence it is lifted by a crane, when the bottom is let down by withdrawing a bolt for discharging the ore into a vessel's hold.

HADLEY'S MACHINE-MADE NAIL WORKS.

The nail trade, among many others, is now undergoing a thorough revolution, which, indeed, is almost entirely accomplished. Machine-made nails have to a large extent superseded those made by hand, while steel is gradually taking the place of iron in their manufacture. The Mitre Nail Works, specially put up for the purpose by Mr. Felix Hadley at Spring Hill, Birmingham, are among the largest in the country, working up 100 tons of raw material weekly. The sheets are brought by a private branch of the Birmingham Canal to the very doors of the factory, and the machines are so arranged that the material passes on in regular sequence, never travelling over the same ground twice. After being weighed and gauged for thickness, the sheets are cut into strips of a width equal to the length of the nail required in guillotine shears, receiving a rapid reciprocating motion from a cam or crank, actuated, as all the machines are, by belting. Moreover, in these works all the operations are performed on the cold metal, thus giving a guarantee of high quality.

With the original machines, the strips are fed in horizontally by hand, the larger by men and the smaller by women, being turned at each stroke, so that the taper of two nails is obtained by a straight feeding in of the strip. In the newer machines, however, the strips are enclosed in a pipe, which is turned half round, backwards and forwards, at each stroke, by means of a leather strap passing over it and worked by a rod from the gear. The consequence of this improvement is that, whereas a practised hand is required to tend each of the old machines, a perfectly unskilled person learns in a day to mind six of the new, having only to put fresh strips in the holders as required. Some of the smaller machines work up as many as six strips, placed side by side, at once, in which case they are turned all together alternately to the right and left, so as to give the taper. Brads are finished by being simply sheared; but "cut" nails are headed by a punch, which gives the larger end a blow, sideways as regards the direction of the feed, while the shank is held firmly between cam dies. As a rule, all the motions are given by two cranks on the main shaft, one in the middle and the other at one end; and each of the 150 or so machines turns out from 100 to 300 nails a minute, according to size. By this automatic machinery, all classes of nails, from those for gates, fencing and hurdles, to the smallest brads and tacks, which formerly were made, not nearly so good, by forging, hot, are produced by what seems to the eye and ear to be only one blow, so rapid is the motion.

In 1878 a new branch was started for making wire nails, which then came largely into demand, the wire being fed from reels horizontally into the machine. As soon as one nail is finished and discharged, the end of the wire, held momentarily between the cam grippers, with roughened surface to prevent slip, receives a smart blow from a punch which forms the head. The wire is then pushed forward the length required for the nail, and two punches advance from either side in a horizontal plane to form the point, when the "knocker-off" throws out the finished nail. So rapidly is this succession of operations performed that the timing of the various motions is a matter of great importance; and, in adjusting a new machine, it is often necessary to file a little off here and slightly lengthen a part there, to ensure accuracy. A great variety of wire nails, including some with oval section shanks for mouldings, are made cold in these machines, from the fine gimp tack to the spike with nearly ½in. shank for tramways. In the case of hob-nails, with a large head in proportion to the shank, the wire is larger than the finished shank, being drawn out in the operation.

The above summary descriptions of the processes are all that can be attempted without elaborate drawings, and the complicated nature of the machines will be imagined when it is said that full-sized drawings of the separate parts of one machine fill six imperial sheets. Moreover, so difficult is the adjustment of parts, that Mr. Hadley defies anyone not accustomed to such machinery to go and make a machine from simply watching its working for, say, three hours together. All the machines are made on the premises, and each new one, called into being by a fresh demand upon the manufacture, contains some improvement of detail suggested by experience.

While wire nails are generally, though not always, left bright, most of the other descriptions are "blued." This operation is now performed in drums revolving over a coke fire, and must not be continued too long, or the succeeding colours of violet, red, and yellow would appear. Steel nails, which have become hardened in the process of making, must be annealed so as to permit of clinching, and this is effected in cylindrical canisters of boiler plate, with the covers carefully luted, placed in a muffle for a given period and then cooled gradually, which has the effect of giving a blue colour at the same time. Siemens and Bessemer steel are used indiscriminately; in fact, Mr. Hadley does not stop to inquire by what process a proposed consignment is made, nor the point of carbon, but tries half a ton in the machines, and if the metal will stand the process it is accepted.

The old brass-headed nails, with forged shank and head cast on, which so frequently lost their heads if not struck with a fair blow, are now almost entirely superseded by machine-made nails having the head encased in brass. Circular discs are stamped out of sheet brass, and then flanged in a power press. The capped disc is then placed flange upwards in the press, with the nail head inserted in it. In the case of small nails, one stroke of the press suffices to close the casing over the head; but in larger sizes this is done at two strokes, so as not to crack the brass at the edges. These and a large variety of nails, of all sorts and sizes, and for every conceivable purpose, are being shown at the Exhibition, Bingley Hall, Birmingham. If, as the President of the Mechanical Engineers remarked the other day in London, cheapening production be a great cause of depression in trade, Mr. Hadley must be accused of having contributed not a little to that unfortunate state of things.

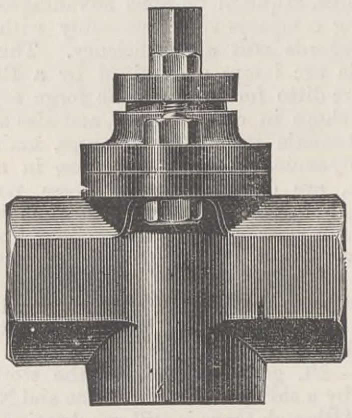
MACHINERY AT THE BIRMINGHAM EXHIBITION.

On each of the three previous occasions when the annual congress of the British Association has been held at Birmingham, there has been opened at the same time an industrial exhibition representing the products and manufacturing processes peculiar to that locality. The first, in 1839, was but a small display, but the second, in 1849, was on a larger scale, and was far more important in many respects. The Prince Consort paid it a visit, and it is claimed for the Exhibition that it suggested to Prince Albert many of the ideas he carried out at Kensington in 1851, and was in fact the foundation of all the many subsequent Exhibitions throughout the country. The third Exhibition, in 1865, was a great success, and there is reason to believe that the display now open in Bingley Hall, simultaneously with the congress, will eclipse all its predecessors. The exhibits are more numerous than ever, and the great strides made in industrial processes of every kind since 1865 will render this Exhibition both instructive and important in a particularly high degree—especially in conjunction with the visits to be made by members of the Association to many of the manufactories and works in the town. The area from which the exhibits are drawn is limited to a radius of fifteen miles, but that circle includes the whole of the black country, and in the other direction extends to Kidderminster, the centre of the carpet trade, to Nuneaton, and to Stourbridge. The exhibits embrace every kind of metal work, a complete representation of the glass industry, stoneware work, carpet making, and silk weaving. The hall is illuminated by the Gülcher electric light, and electricity is largely used as a motive power for the machinery-in-motion. Last week we mentioned a few of the exhibits incidentally, but there are many more deserving of notice.

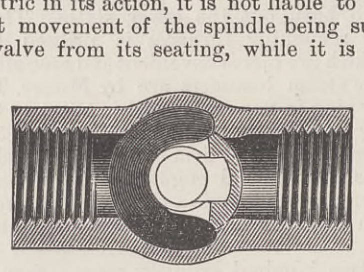
For example, Messrs. Wm. Causen and Co., hydraulic and general engineers, display a collection of lifts, screw jacks, pulley blocks, machines, nail and rivet-making, tools used in machine shops, &c. Some of the hydraulic lifting jacks are for loads varying from 3 to 200 tons, which only require one man at the lever. There are ship jacks for launching ships or other heavy bodies from 20 to 200 tons power; and there are also pulling jacks which can be made to any length of run-out, and are especially useful for pulling up stumps of trees and other deep-rooted masses. Besides these, there are special hydraulic jacks for various purposes, such as railway jacks for raising locomotive carriages and trucks during repairs or erection. They also show a working model of Bennett's hydraulic lift, which, it is said, possesses these advantages over other hoists—that the risk is reduced to a minimum, the pressure on the pistons being always a compressive force acting through metal pellets, which, while admitting of a certain amount of flexibility in movement, are perfectly rigid in compression, and consequently the pistons of the hoists are always supporting the load directly, and without loosening the head. There is no heavy ram to counterbalance, there are no stuffing-boxes, and the weight of the machinery of the lift is reduced to a minimum. Further, the lift is applicable to raising and lowering passengers, or merchandise in warehouses, manufactories, or hotels, and is positive in action and easy to work. Another striking exhibit by this firm is one of Blanchi's patent machines for making wire nails, the advantages of which are that the manifold arrangements of levers and contrivances generally in vogue in this class of machinery are considerably reduced, and the machine can be run at a higher speed, and therefore give out a greater quantity of nails in a given time than the machines commonly in use.

A patent gas hammer, now exhibited for the first time in this country, is contributed by Messrs. Tangye and Co. This machine is described as possessing the same advantages as the steam hammer, but as far more economical, for it will strike 2500 blows with the expenditure of only a pennyworth of gas. The same company also show a 4-horse power gas engine, with an automatic arrangement for keeping the engine slowly in motion when not required for use, and also a new type of steam pump for colliery and other purposes, and a centrifugal pump and steam engine combined, which is likewise shown for the first time. The machinery occupies very little space, and all the intricate parts are covered to prevent damage from damp. Messrs. Tangye also exhibit an automatic arrangement for cutting off the steam from engines, and a sight-feed lubricator, which, it is predicted, will supersede the old-fashioned lubricating appliance. A very ingenious and novel exhibit consists of a variety of automatic weighing machines displayed by Messrs. W. and J. Avery. These machines are so constructed that the substance placed in a receptacle will continue apportioning out whatever weight it has been adjusted to while the operator is kept busily tying up the parcels. One of the machines simply requires an assistant to keep the apparatus supplied with empty packages, and the machines revolving once round the packages are returned filled with the desired weight of contents. Some of the machines have three receptacles into which different commodities may be measured, so that while one pound is being packed up another is being weighed out; while another machine is for weighing grain per bushel and recording the amount by means of a register. Messrs. Day and Millward, scale and balance makers, also exhibit a number of scales and platform weighing machines, which are remarkable for their simplicity of mechanism. Loose parts or links in the bottom frame are dispensed with, and the fact that 15,000 of these machines have been supplied by the firm speaks for their efficiency. Among the collection is a platform machine working entirely without loose weights, and fitted with improved relieving gear. To illustrate carpet-making, Messrs. Brinton and Co., of Kidderminster, show a loom in full working order, which is capable of weaving carpet pieces 45 yards long by 29in. wide, and weaving in a great variety of colours.

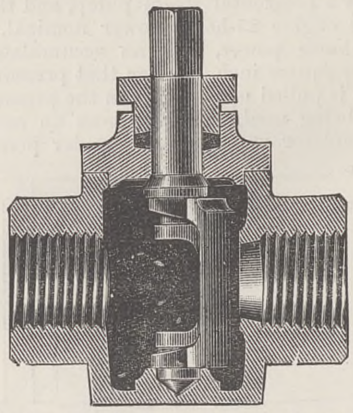
Messrs. John Cartwright and Sons, of Birmingham, show Messrs. Hunt and Green's valve, as illustrated by the accompanying engravings. It is a simple valve and has



been designed by Mr. C. Hunt, C.E., as a substitute for the ordinary plug cock, or smaller sizes of slide valves. Being excentric in its action, it is not liable to stick fast, a very slight movement of the spindle being sufficient to release the valve from its seating, while it is capable of



withstanding any required pressure when in action. Its use is more especially commended is gas works, as it will, it is believed, avoid the necessity and occasional risk of periodically easing the main taps and valves. It is also represented as specially applicable as a steam boiler blow-



off valve. In the Exhibition it is also shown as adapted for a steam engine stop valve and governor combined, and for this purpose is in use in the Windsor-street gasworks on an engine running at 200 per minute, and on a tar pump working at but 40 per minute.

Messrs. James Russell and Sons, of Wednesbury, show a large number of marine and other boiler tubes up to 15in. diameter; iron and steel tubes for shipbuilding, architectural, and other purposes; valves for regulating the pressure of steam from high to low-pressure, and a variety of gas tubes; a section of a hydraulic ram tube used for lifts, made of Siemens-Martin's steel, 60in. wide, ⅝in. thick, and 11ft. 6in. long. A hydraulic ram similar to this was used for the Mersey tunnel scheme, and is in operation at the present time, the appliances being capable of lifting a hundred people in a few seconds, from the railway to the ground above.

By Messrs. Thomas Piggott and Co. there is exhibited one of their well-known Atlas horizontal engines of 14-horse power, with Wills' patent automatic expansion gear and governor, driven by cam shaft direct from the main shaft. The cams are designed to give an automatic cut-off at any portion of the stroke so as to admit just as much steam as may be required to do the work. The same firm also show a Lancashire steam boiler, 30ft. by 7ft., fitted with Arnold's patent anti-collapsible flues, which are constructed in barrel form, and impart greater strength, while at the same time affording a larger extent of heating surface. This patent enables, it is claimed, a plate five-sixteenths of an inch in thickness to sustain equal pressure with one half an inch thick. Another object in this assortment is an ingenious apparatus for indicating the depth of water in a boiler. When the water is too low an indication of the fact is given by the ringing of an alarm bell, which at once draws the attention of the engineer in charge. Besides these larger exhibits illustrating machinery, there are numerous smaller exhibits connected with inventions. The New British Iron Company, for instance, contribute specimens of their Congreaves and Lion brands of pig iron and their Lion brands of finished iron and specialities of steel. In the "Congreaves' brands of pig and finished iron, thin composite steel and iron is produced, which is found highly valuable for some manufacturing processes. The material is made by a combination of steel and iron, which, in bars, plates, &c., gives practically the qualities of steel, while the iron wire with which it is interspersed secures the facilities of welding and easy manipulation in the smith's fire which appertain to iron. Possessing the fibrousness of iron, it is not liable to fail by cracking or tearing across, as sometimes happens with steel; and this renders it specially valuable for boiler plates, chains, railway axles, &c. It is stated that cables and chains made of this material have given in the case of cables 108 per cent., and in the case of short link chains as much as 262 per cent. higher resistance when tested to destruction, than the Admiralty tensile tests, while the wear of the material is enormously increased over iron. The material is also used for the manufacture of sporting gun barrels, the intermixture of the iron and steel giving in this case a very beautiful pattern to the surface of the barrel when finished and bronzed. Messrs. John Cartwright and Sons exhibit a number of Hunt and Green's patent valves, which are designed as a substitute for the ordinary plug cock or smaller sizes of slide valves; and Messrs. F. H. Lloyd and Co., of Wednesbury, display a considerable number of samples and test pieces of cast steel, and also a complete railway crossing.

THE BRITISH ASSOCIATION IN BIRMINGHAM

Although it may be true that science owes to industry much more than industry does to science, the latter has certainly laid the former under many obligations. Birmingham owes much to science, although few towns have done so much to enable science to incur the debt. It may therefore appear fitting that the British Association for the Advancement of Science should again visit that town, although it be for the fourth time in less than forty years. Not only do four of the chief branches of science, namely, mathematics, physics, chemistry, and mechanics, depend for the interest that ordinarily attaches to them upon their practical applications, but practical applications result in developments, in breaking down barriers which to science have seemed impenetrable, or in discoveries which open up new fields for scientific investigation. Science cannot, therefore, do better than visit Birmingham to find out what Birmingham is doing. In 1865 Professor John Phillips, as President of the Geological Section, referred to the interdependence of science and industrial art, but as a leader in a branch of science which would find it most difficult to point to its own in Birmingham, he was inclined to claim too high a relative position for science, although his own words in some respects led to the remark that science was born in the workshop and nursed in the laboratory by study. Phillips said:—"Assembled in this busy centre of industrious England, amid the roar of engines and clang of hammers, where the strongest powers of nature are trained to work in the fairy chains of art, how softly and fittingly falls upon the ear the accent of science, the friend of that art, and the guide of that industry! Here where Priestley analysed the air, and Watt obtained the mastery over steam, it well becomes the students of nature to gather round the standard which they carried so far into the fields of knowledge; and when on other occasions we meet in quiet colleges and academic halls, how gladly welcome is the union of fresh discoveries and new inventions with the solid and venerable truths which are there treasured and taught. Long may such union last; the fair alliance of cultivated thought and practical skill; for by it labour is dignified and science fertilised, and the condition of human society exalted."

Well, science has gone to Birmingham to be refertilised, and in some directions wants it badly, including mechanical science, dealt with by Section G of the British Association. This section has usually afforded more to interest our readers than any of the others, and this year the number of papers that have been presented or whose titles have been sent in is unusually large. Quantity, however, may unfortunately be the highest quality.

The address of the President of the Association, Sir J. William Dawson, F.R.S., Principal of the McGill University of Montreal, which opened the proceedings on Wednesday evening, was devoted, as might be expected from so famed a geologist, to certain physiographical questions of great interest to geologists and physicists, but not sufficiently belonging to the practical sciences to permit of its publication at length in our pages. Upon ordinary geological matters Sir W. Dawson would necessarily find Canadian and American examples more readily occurring to his mind than recognisable by an English audience, and he therefore took as the main feature of his address a consideration of the broad problems involved in a study and explanation of the origin of the great oceans. Like several of the leading geologists of America, the great mechanical and thermo-dynamical actions which have obviously played so great a part by tangential and orthogonal pressures in the formation of the surface of our earth, find in the President a ready student and an able interpreter. After a popular introduction, followed by general remarks leading to the above-mentioned subject, Sir William Dawson attacked his subject by a categorical statement of the knowledge and evidence upon which he relied for an answer to certain questions.

"We are invited," he said, "by the preceding glance at the surface of the earth to ask certain questions respecting the Atlantic. (1) What has at first determined its position and form? (2) What changes has it experienced in the lapse of geological time? (3) What relations have these changes borne to the development of life on the land and in the water? (4) What is its probable future? Before attempting to answer these questions, which I shall not take up formally in succession, but rather in connection with each other, it is necessary to state as briefly as possible certain general conclusions respecting the interior of the earth. It is popularly supposed that we know nothing of this beyond a superficial crust perhaps averaging 50,000 to 100,000ft. in thickness. It is true we have no means of exploration in the earth's interior, but the conjoined labours of physicists and geologists have now proceeded sufficiently far to throw much inferential light on the subject, and to enable us to make some general affirmations with certainty; and these it is the more necessary to state distinctly, since they are often treated as mere subjects of speculation and fruitless discussion. (1) Since the dawn of geological science it has been evident that the crust on which we live must be supported on a plastic or partially liquid mass of heated rock, approximately uniform in quality under the whole of its area. This is a legitimate conclusion from the wide distribution of volcanic phenomena, and from the fact that the ejections from volcanoes, while locally of various kinds, are similar in every part of the world. It led to the old idea of a fluid interior of the earth, but this is now generally abandoned, and this interior heated and plastic layer is regarded as merely an under-crust. (2) We have reason to believe, as the result of astronomical investigations, that notwithstanding the plasticity or liquidity of the under-crust, the mass of earth—its nucleus as we may call it—is practically solid and of great density and hardness. Thus we have the apparent paradox of a solid yet fluid earth; solid in its astronomical relations, liquid or plastic for the purposes of volcanic action and superficial movements.[1] (3) The plastic sub-crust is not in a state of dry igneous fusion, but in that condition of aqueo-igneous or hydro-thermic fusion which arises from the action of heat on moist substances, and which may either be regarded as a fusion or as a species of solution at a very high temperature. This we learn from the phenomena of volcanic action, and from the composition of the volcanic and plutonic rocks, as well as from such chemical experiments as those of Daubrée and of Tilden and Shenstone. (4) The interior sub-crust is not perfectly homogeneous, but may be roughly divided into two layers or magmas, as they have been called: an upper, highly siliceous or acidic, of low specific gravity and light-coloured, and corresponding to such kinds of plutonic and volcanic rocks as granite and trachyte; and a lower, less siliceous or more basic, more dense, and more highly charged with iron, and corresponding to such igneous rocks as the dolerites, basalts, and kindred lavas. It is interesting here to note that this conclusion, elaborated by Durocher and von Waltershausen, and usually connected with their names, appears to have been first announced by John Phillips, in his 'Geological Manual,' and as a mere common-sense deduction from the observed phenomena of volcanic action and the probable results of the gradual cooling of the earth. It receives striking confirmation from the observed succession of acidic and basic volcanic rocks of all geological periods and in all localities. It would even seem, from recent spectroscopic investigations of Lockyer, that there is evidence of a similar succession of magmas in the heavenly bodies, and the discovery by Nordenskiöld of native iron in Greenland basalts, affords a probability that the inner magma is in part metallic. (5) Where rents or fissures form in the upper crust, the material of the lower crust is forced upward by the pressure of the less-supported portions of the former, giving rise to volcanic phenomena either of an explosive or quiet character, as may be determined by contact with water. The underlying material may also be carried to the surface by the agency of heated water, producing those quiet discharges which Hunt has named crenitic. It is to be observed here that explosive volcanic phenomena, and the formation of cones, are, as Prestwich has well remarked, characteristic of an old and thickened crust. Quiet ejection from fissures and hydrothermal action may have been more common in earlier periods, and with a thinner over-crust. (6) The contraction of the earth's interior by cooling, and by the emission of material from below the over-crust, has caused this crust to press downward, and therefore laterally, and so to effect great bends, folds, and plications; and these, modified subsequently by surface denudation, constitute mountain chains and continental plateaus. As Hall long ago pointed out, such lines of folding have been produced more especially where thick sediments had been laid down on the sea bottom. Thus we have here another apparent paradox—namely, that the elevations of the earth's crust occur in the places where the greatest burden of detritus has been laid down upon it, and where consequently the crust has been softened and depressed. We must beware, in this connection, of exaggerated notions of the extent of contraction and of crumpling required to form mountains. Bonney has well shown, in lectures delivered at the London Institution, that an amount of contraction, almost inappreciable in comparison with the diameter of the earth, would be sufficient; and that as the greatest mountain chains are less than $\frac{1}{600}$th of the earth's radius in height, they would on an artificial globe a foot in diameter be no more important than the slight inequalities that might result from the paper gores overlapping each other at the edges. (7) The crushing and sliding of the over-crust implied in these movements raise some serious questions of a physical character. One of these relates to the rapidity or slowness of such movements, and the consequent degree of intensity of the heat developed, as a possible cause of metamorphism of rocks. Another has reference to the possibility of changes in the equilibrium of the earth itself as resulting from local collapse and ridging. These questions in connection with the present dissociation of the axis of rotation from the magnetic poles, and with changes of climate, have attracted some attention, and probably deserve further consideration on the part of physicists. In so far as geological evidence is concerned, it would seem that the general association of crumpling with metamorphism indicates a certain rapidity in the process of mountain-making, and consequent development of heat, and the arrangement of the older rocks around the Arctic basin forbids us from assuming any extensive movement of the axis of rotation, though it does not exclude changes to a limited extent. I wish to formulate these principles as distinctly as possible, and as the result of all the long series of observations, calculations, and discussions since the time of Werner and Hutton, and in which a vast number of able physicists and naturalists have borne a part, because they may be considered as certain deductions from our actual knowledge, and because they lie at the foundation of a rational physical geology. We may popularise these deductions by comparing the earth to a drupe or stone-fruit, such as a plum or peach, somewhat dried up. It has a large and intensely hard stone and kernel, a thin pulp made up of two layers, an inner more dense and dark coloured, and an outer less dense and lighter coloured. These constitute the under-crust. On the outside it has a thin membrane, or over-crust. In the process of drying it has slightly shrunk, so as to produce ridges and hollows of the outer crust, and this outer crust has cracked in some places, allowing portions of the pulp to ooze out—in some of these its lower dark substance, in others its upper and lighter material. The analogy extends no farther, for there is nothing in our withered fruit to represent the oceans occupying the lower parts of the surface or the deposits which they have laid down. Though the Atlantic is a deep ocean, its basin does not constitute so much a depression of the crust of the earth as a flattening of it, and this, as recent soundings have shown, with a slight ridge or elevation along its middle, and banks or terraces fringing the edges, so that its form is not so much that of a basin as that of a shallow plate with its middle a little raised. Its true permanent margins are composed of portions of the over-crust folded, ridged up, and crushed, as if by lateral pressure emanating from the sea itself. We cannot, for example, look at a geological map of America without perceiving that the Appalachian ridges, which intervene between the Atlantic and the St. Lawrence Valley, have been driven bodily back by a force acting from the east, and that they have resisted this pressure only where, as in the Gulf of St. Lawrence and the Catskill region of New York, they have been protected by outlying masses of very old rocks, as, for example, by that of the island of Newfoundland and that of the Adirondack Mountains. The admirable work begun by Professor James Nicol, followed up by Hicks, Lapworth, and others, and now fully confirmed by the recent observations of the geological survey of Scotland, has shown the most intense action of the same kind on the east side of the ocean in the Scottish highlands; and the more widely-distributed Eozoic rocks of Scandinavia may be appealed to in further evidence of this. If we now inquire as to the cause of the Atlantic depression, we must go back to a time when the areas occupied by the Atlantic and its bounding coasts were parts of a shoreless sea in which the earliest gneisses or stratified granites of the Laurentian age were being laid down in vastly extended beds."

The address was well received by a large part of a very large audience.

Yesterday the several sections commenced work, the sectional Presidents opening the proceedings with an address. The President of the Mechanical Section, Sir James N. Douglass, M.I.C.E., dealt with a difficult subject in a very successful and interesting manner, and in his address, of which we give a long abstract in another place, gave a general review of the rise and development of lighthouse engineering in theory and practice.

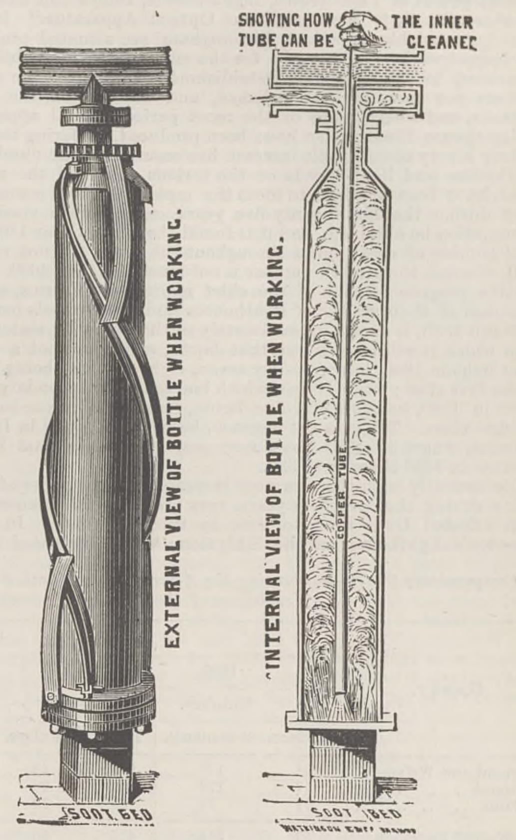
Amongst other papers to be read in this section are the following:—"Girder Bridges," by Messrs. W. Shelford and Shield; "Cantilever Bridges," by Messrs. Clarke and MacDonald; "Freezing Foundations," by Mr. O. Reichenbach; "Laffite Plates," by Mr. W. Anderson, M.I.C.E.; "Compound Engines," by Mr. J. Richardson; "Forced Draught," by Mr. J. R. Fothergill; "Revolving Engines," by Arthur Rigg, &c. On other pages will be found accounts of some of the works open to the members of the Association.

[1] Hopkins, Mallet, Sir William Thomson, and Professor G. H. Darwin maintain the solidity and rigidity of the earth on astronomical grounds; but different conclusions have been reached by Hennesey, Delaunay, and Airy. In America Barnard and Crosby, Dutton, Le Conte, and Wadsworth have discussed these questions.

The Society of Engineers.—Arrangements have been made for the members and associates of the Society and their friends to visit, on Tuesday, September 7th, the National Agricultural Hall, Kensington, which adjoins the west side of Kensington—Addison-road—station, and the electrical works of Messrs. Woodhouse and Rawson, Cadby Hall, West Kensington, which are within half a mile of the Hall. The roof of the hall is next in span, among London roofs, to that of St. Pancras Station; and at Messrs. Woodhouse and Rawson's works the new Upward's Primary Batteries will be shown, which are now attracting great attention. The party will assemble at the entrance to the Hall from the Hammersmith-road at 1.30 p.m. It is expected that Messrs. Woodhouse and Rawson's works will be reached at about 3.30 p.m. Tickets for the visit, without which no one will be admitted to either of the works, will be supplied on application to the secretary of the Society.

ELSON'S FUEL ECONOMISER SCRAPER.

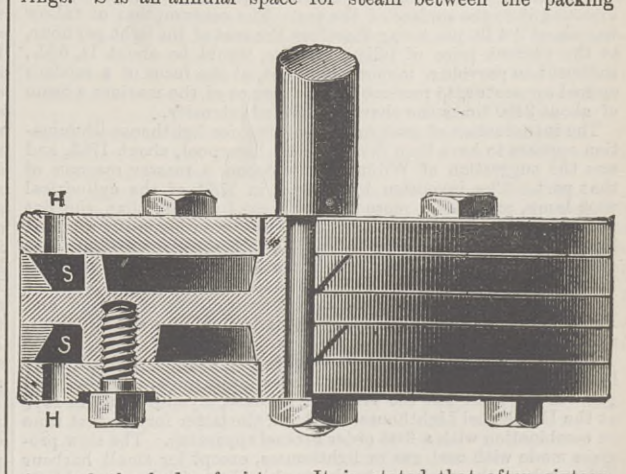
Scrapers designed to scrape off the non-conducting adherent soot on economiser tubes are necessary, and to avoid the inefficiency of the scraper through bluntness, Mr. Elson, of Lee-street, Oldham, has made the scraper shown in the accompanying engravings. The scraper is made of steel blades, one-sixteenth of an inch in thickness, placed and used edgewise, so that the edge is never more than the sixteenth thick, and thus scrapes instead of rubbing the soot partly off and partly hardening it on the tube surface. It is held with its edge to the "bottle" between spiral or twisted wrought iron rods or guide frames, the pressure upon which can be regulated at will. The scraper not being fast to the guide frame, the old one can be taken out and a new one replaced in a very short time, thus saving much labour, expense, and trouble common with sliding



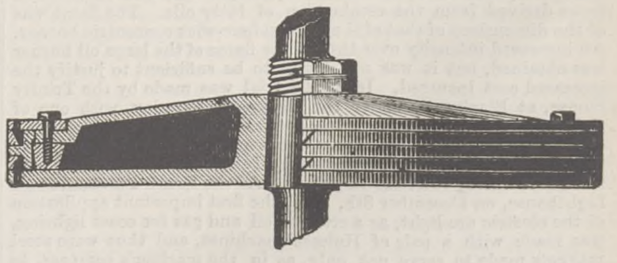
scrapers. It is used in Mr. Elson's economiser, in which each bottle is free to expand and contract separately and independently, and he claims as an advantage that any one pipe or bottle can be removed or replaced without going into the flue or pulling down the brickwork. The scraper, he says, dispenses with tumblers, changing motion, and bevel-gearing, only two journals requiring lubricating, and requires less power for driving the scraper, an ordinary half-inch band and grooved pulley being sufficient to drive two sets. Each bottle being supplied with water through a brass tube, and thereby effecting a uniform circulation, no inconvenience is found whatever with the force pump in case of the water getting too hot in the economiser.

SMALLEY'S PISTONS.

The accompanying engravings illustrate a piston patented and manufactured by Messrs. Smalley, Rice, and Evans, engineers, Stanhope-street, Liverpool. It is of that type in which the springs are forced out by the pressure of steam acting behind them. The packing rings have the particular shape which enables them to expand to the inner surface of the cylinder by the pressure of the steam without undue friction. H are holes through the junk-plates, to admit steam to the packing rings. S is an annular space for steam between the packing



ring and the body of piston. It is stated that after sixteen months' continuous working a piston shows the packing rings to be as good as when first put in—the piston not even requiring cleaning; the cylinder inside and the packing rings were per-



fectly smooth, and the latter equal in thickness throughout their circumference, as at first, thus showing that the pressure had been equally distributed on the inner surface of the packing rings. The invention has been patented by Mr. Smalley.

BRITISH ASSOCIATION.

LIGHTHOUSES, LIGHT-VESSELS, BUOYS, AND BEACONS.[1]

At the Birmingham meetings in 1839, 1845, and 1865, the following papers special to this section were read and discussed, viz., 1839, "Testing Iron by long-continued Strains;" "Proportion of Power to Tonnage in Steam Vessels;" and "Wood Paving with Vertical Blocks." In 1845, "Machine Ventilation for Coal Mines;" "Centrifugal Pump—improved principle;" "Balancing Locomotive Wheels;" "Oil Testing by Mechanical Means;" "Chemical Copying Telegraphs;" and "Macadamised Roads—superiority." In 1865, "Bessemer Steel Manufacture as substituted for that of Wrought Iron;" "Siemens' Regenerative Furnace and Gas Producer;" "Hot Blast for Furnaces at very High Temperatures;" "Compressed Air Machinery for Transmitting Power;" "Weldless Tires;" "Giffard's Injector;" "Covering of Deep Sea Telegraph Cables." I propose to address you on a subject with which I have been practically connected for nearly half a century, that is, the "Development of Lighthouses, Light-vessels, Buoys and Beacons, together with their Mechanical and Optical Apparatus." In the immediate neighbourhood of Birmingham are situated probably the largest works in the world for the manufacture of lighthouse apparatus, indeed the only establishment in which the glass portions are cast, ground, polished, and finished on the same premises, and where many of the most perfect optical apparatus for lighthouse illumination have been produced. During the last century a very considerable increase has occurred in the number of lighthouses and light-vessels on the various coasts of the world, which have been required to meet the rapid growth of commerce. Only during the last twenty-five years can accurate statistical information be obtained, and it is found that in the year 1860 the total number of coast lights throughout the world did not exceed 1800, whereas the present number is not much less than 4000. The relative progress of each of the chief maritime countries, in the extension of their system of lighthouses and light-vessels between 1860 and 1885, is shown approximately in the following statement, from which it will be observed that Japan, which had not a single coast light in 1860, has now fifty-seven, eight of these being lights of the first class; while China, which had only four secondary coast lights in 1860, has now fifty-five lights, fourteen of these being of the first class. The greatest increase, however, is found in British America, where in 1860 there were only ninety-one coast lights, whereas in 1885 there were 380.

Concurrently with the enormous increase in the number of coast lights during the last fifty years, very great improvements have been effected from time to time in their efficiency. In 1759 Smeaton's lighthouse on the Eddystone was illuminated by 24 tallow candles, weighing ⅖ lb. each. The intensity of the light of each candle, I find, from experiments made with similar candles prepared for the purpose, to have been about 2·8 candle units each; thus the aggregate intensity of radiant light from the 24 candles was only about 67 candle units. No optical apparatus, moreover, was used for condensing the radiant light of the candles, and directing it to the surface of the sea. The consumption of tallow was about 3·4 lb. per hour; therefore the cost of the light per hour, at the current price of tallow candles, would be about 1s. 6½d., sufficient to provide a mineral oil light, at the focus of a modern optical apparatus, to produce for the service of the mariner a beam of about 2400 times the above-mentioned intensity.

Comparative Statement showing the Approximate Number and Description of the Coast Lights in the chief Countries of the World (exclusive of their outlying possessions), in the Years 1860 *and* 1885 *respectively.*

Country.	Lighthouses.									Light Vessels.		
	1860.			1885.			Increase.			1860.	1885.	
	Number.			Number.			Number.					
	1st Class.	Secondary.	Total.	1st class.	Secondary.	Total.	1st class.	Secondary.	Total.	Number	Number	Increase.
England and Wales ..	24	178	202	43	296	339	19	118	137	42	57	15
Scotland	17	112	129	23	166	189	6	54	60	1	4	3
Ireland	11	74	85	19	108	127	8	34	42	5	11	6
United Kingdom ..	52	364	416	85	570	655	33	206	239	48	72	24
United States	26	314	340	52	406	458	26	92	118	39	22	17* (Decrease)
France	32	193	225	39	374	413	7	181	188	3	9	6
British America	4	87	91	5	375	380	1	288	289	1	8	7
Sweden and Norway ..	3	115	118	8	321	329	5	206	211	2	8	6
Italy	3	88	91	17	220	237	14	132	146	—	12	12
Russia	2	63	65	14	164	178	12	101	113	12	16	4
Australia	6	33	39	18	172	190	12	139	151	5	14	9
Austria	—	10	10	1	156	157	1	146	147	—	1	1
Denmark	2	68	70	7	158	165	5	90	95	7	11	4
Spain	9	41	50	11	167	178	2	126	128	—	—	—
Netherlands	3	55	58	8	94	102	5	39	44	—	3	3
India	—	42	42	14	99	113	14	57	71	7	9	2
Germany	1	31	32	10	80	90	9	49	68	8	22	14
New Zealand	—	3	3	6	66	72	6	63	69	—	2	2
China	—	4	4	14	41	55	14	37	41	1	13	12
Turkey	1	13	14	1	54	55	—	41	41	1	3	2
Japan	—	—	—	8	49	57	8	49	57	—	2	2
Brazil	—	16	16	6	43	49	6	27	33	—	1	1
Portugal	1	14	15	1	19	20	—	5	5	—	—	—
Belgium	1	5	6	1	21	22	—	16	16	2	3	1
Totals	146	1559	1705	326	3649	3975	180	2090	2270	136	231	95

* This is in consequence of a large number of permanent lighthouses having been substituted for light vessels.

The introduction of catoptric apparatus for lighthouse illumination appears to have been first made at Liverpool, about 1763, and was the suggestion of William Hutchinson, a master mariner of that port. The invention by Argand, in 1782, of the cylindrical wick lamp, provided a more efficient focal luminary than the flat-wick lamp previously employed, and was soon generally adopted for both fixed and revolving lights. In 1825 the French lighthouse authorities effected another very important improvement in lighthouse illumination, by the introduction of the dioptric system of Fresnel, in conjunction with the improvements of Arago and Fresnel on the Argand lamp, by the addition of a second, third, and fourth concentric wick.

Coal and wood fires, followed by tallow candles and oil, have been referred to as the early lighthouse illuminants. In 1827 coal gas was introduced at the Troon Lighthouse, Ayrshire, and in 1847 at the Hartlepool Lighthouse, Durham, the latter for the first time in combination with a first order Fresnel apparatus. The slow progress made with coal gas in lighthouses, except for small harbour lights, where the gas could be obtained in their vicinity, was chiefly due to the great cost incurred in the manufacture of so small a quantity as that required and at an isolated station. In 1839 experiments were made at the Orford Low Lighthouse, Suffolk, with the Bude light of the late Mr. Goldsworthy Gurney. This light was produced by throwing oxygen gas into the middle of a flame derived from the combustion of fatty oils. The flame was of the dimensions of that of the Fresnel four-wick concentric burner. An increased intensity over that of the flame of the large oil burner was obtained, but it was not found to be sufficient to justify the increased cost incurred. In 1857 a trial was made by the Trinity House, at Blackwall, under the advice of Faraday, with one of Holmes' direct current magneto-electric machines for producing the electric arc light for a lighthouse luminary, and the experiment was found to be so full of promise for the future that a practical trial was made during the following year. At the South Foreland High Lighthouse, on December 8th, 1858, the first important application of the electric arc light, as a rival to oil and gas for coast lighting, was made with a pair of Holmes' machines, and thus were steel magnets made to serve not only, as in the mariner's compass, to guide him on his path, but also to warn him of danger. In 1859 the experimental trials at the South Foreland were discontinued, but they were sufficiently encouraging to lead to the permanent installation of the electric light at Dungeness Lighthouse in 1862. In 1863 the electric arc light was adopted by the French Lighthouse Authorities at Cape La Hève. In 1871, after practical trials with a new alternating current machine of Holmes, two of such machines were supplied to a new lighthouse on Souter Point, Coast of Durham, and in the following year the electric arc light, with these machines, was established in both the high and low lighthouses at the South Foreland, where it still shines successfully. The early experience with the electric light at Dungeness was far from encouraging. Frequent extinctions of the light occurred from various causes connected with the machinery and apparatus, and the oil light had at such times to be substituted. As no advantage can counterbalance the want of certainty in signals for the guidance of the mariner, no further step in the development of the electric light was taken by the Trinity House until the latter part of 1866, when favourable reports were received from the French Lighthouse Authorities of the working of the Alliance Company's system at the two lighthouses of Cape La Hève. Complaints were also received from mariners, in the locality of Dungeness, of the dazzling effect on the eyes when navigating, as they are there frequently required to go close inshore, thus being prevented from rightly judging their distance from this low and dangerous point. Therefore in 1874 the electric light was removed from Dungeness, and a powerful oil light substituted. In 1877 the electric arc light was installed at the Lizard Lighthouses on the south coast of Cornwall, and arrangements are now being made for establishing it at St. Catherine's Lighthouse, Isle of Wight, and at the High Tower, on the Isle of May, Firth of Forth. I have mentioned that the first machines of Holmes at the South Foreland were direct current, the machines provided by him for Dungeness being also of the same type. The French Lighthouse Authorities, however, adopted for their lighthouses at Cape La Hève the Alliance alternating current magneto-electric machines, and, in consequence of the less wear and tear of these machines, with greater reliability through their having no commutator, Holmes was required to supply alternating current machines for Souter Point and the South Foreland. Those machines have been running at these stations fourteen years and fifteen years respectively. They have, during this period, required only a very trifling amount of repair, and are still in excellent order, but the time must soon arrive for replacing them by more powerful machines.

In 1876 a series of trials was made by the Trinity House at the South Foreland, with various dynamo-electric machines, for the purpose of ascertaining the then most suitable machine for adoption at the Lizard. The results were decidedly in favour of the Siemens direct current machine, and machines of this type were accordingly installed at the Lizard station in 1878. In consequence of irregularities in their working, and because at the time Baron de Meritens, of Paris, had perfected a very powerful alternating current machine, it was resolved to send one of the latter machines to the Lizard for trial, where it has worked most satisfactorily for several years. The experience gained at the Lizard suggested that, for the St. Catherine's station, where it had been resolved to adopt the electric arc light, the De Meritens machines should be employed, and they were accordingly ordered; but, as arrangements were then being made for experiments at the South Foreland for testing the relative merits of electricity, gas, and oil as lighthouse illuminants, it was determined that these machines should first be sent there for the experiments. In 1862 a practical trial was made by the Trinity House, at the South Foreland, of the Drummond or lime-light, but the results were not so satisfactory, after experience with the electric arc light, as to encourage its adoption. In the meantime the successful development of the electric arc light for lighthouse illumination very soon acted as a keen stimulus to inventors of burners for producing gas and oil luminaries for the purpose; in 1865 the attention of lighthouse authorities was directed to the gas system of Mr. John R. Wigham, of Dublin, which system was tried in that year by the Commissioners of Irish Lights at the Howth Bailey Lighthouse, near Dublin, and in 1878 he introduced, at the Galley Head Lighthouse, County Cork, his system of superposed gas burners. In 1861 experiments were made by the Trinity House for the purpose of determining the efficiency and economy of mineral oils in relation to colza for lighthouse illumination; but, owing to the imperfectly refined oil then obtainable, and its high price, the results were not found to be so satisfactory as to justify a change from colza oil, at that time generally used. In 1869 the price of mineral oil, of good illuminating quality and safe flashing point, having been reduced to about one-half the price of colza, the Trinity House determined to make a further series of experiments, when it was ascertained that, with a few simple modifications, the existing burners were rendered very efficient for the purpose, and a change from colza to mineral oil was commenced. It was found, during these experiments, that the improved combustion effected in the colza burners, in their adaptation for consuming mineral oils, had the effect of increasing their mean efficiency, when burning colza, 45⅔ per cent. A further advance was made, during these experiments, by increasing the number of wicks of the first order burner from four to six, more than doubling the intensity of the light, while effecting an improved compactness of the luminary per unit of focal area of 70 per cent.

There are at present not less than eighty-six distinctive characters in use throughout the lighthouses and light-vessels of the world; and, as their numbers increase, so does the necessity for giving a more clearly distinctive character to each light over certain definite ranges of coast. This important question of affording to each light complete distinctive individuality is receiving the attention of lighthouse authorities at home and abroad, and it is hoped that greater uniformity and consequent benefit to the mariner will be the result. The modern steam vessel is expected to keep time with nearly the same degree of precision as a railway train, and it is evident that, even with the utmost care and attention on the part of her commander, this requirement cannot possibly be fulfilled, and collisions and strandings must occur, unless efficient sound signals for fog be carried by each vessel, and powerful signals of this class be provided at lighthouse and light-vessel stations. These circumstances have led to a rapid development of fog signals, both ashore and afloat; there being now about 700 of these signals, of various descriptions, on the coasts of the world. We therefore find, as might have been naturally expected, that coast fog signals have been made, by lighthouse authorities, the subject of careful experiment and scientific research; but, unfortunately, the practical results thus far have not been so satisfactory as could be desired, owing: First, to the very short range of the most powerful of these signals under occasional unfavourable conditions of the atmosphere during fog; and, secondly, to the present want of a reliable test for enabling the mariner to determine at any time how far the atmospheric conditions are against him in listening for the anxiously-expected signal. In 1854 some experiments on different means of producing sounds for coast fog signals were made by the engineers of the French Lighthouse department, and in 1861-62 MM. Le Gros and St. Ange Allard, of the Corps des Ponts et Chaussées, conducted a series of experiments upon the sound of bells and the various methods of striking them.

In 1863-64 a Committee of the Elder Brethren of the Trinity House made some experiments at Dungeness upon various fog signals. In June, 1863, a Committee of the British Association memorialised the then President of the Board of Trade with the view of inducing him to institute a series of experiments upon fog signals. The experiments were not, however, carried out. In 1864 a series of experiments was undertaken by a Commission appointed by the Lighthouse Board of the United States, to determine the relative powers of various fog signals which were brought to the notice of the Board. In 1872 a Committee of the Trinity House visited the United States and Canada, with the object of ascertaining the actual efficiency of various fog signals then in operation on the North American Continent, about which very favourable reports had reached this country. Among other instruments, they witnessed the performance of a Siren apparatus patented by Messrs. A. and F. Brown, of New York. One of these instruments was, in 1873, very kindly sent to the Trinity House by the United States authorities, and tested with other instruments in the experimental trials at the South Foreland in 1873-74. This investigation was carried out at the South Foreland by the Trinity House, with the object of obtaining some definite knowledge as to the relative merits of different sound-producing instruments, and also of ascertaining how the propagation of sound was affected by meteorological phenomena. These experiments were extended over a lengthened period, in all conditions of weather, and the well-known scientific and practical results obtained, together with the ascertained relative merits of sound-producing instruments for the service of the mariner, are of the highest scientific interest and practical importance. The investigation at the South Foreland was followed up by the Trinity House by further experiments, in which they were assisted by the authorities at Woolwich, with guns of various forms, weight of charges, and descriptions of gunpowder. The powders tested were (1) fine grain, (2) larger grain, (3) rifle large grain, and (4) pebble. The result placed the powders exactly in the order above stated. It was found that charges of gun-cotton yielded reports louder at all ranges than equal charges of gunpowder, and further experiments proved that the explosion of ¼ lb. of gun-cotton gave a result at least equal to that produced by 3 lb. of the best gunpowder. These results led the Trinity House to adopt this explosive as a fog signal for isolated stations on rocks or shoals where previously from want of space nothing better than a bell could be applied. But wherever the Siren can be installed, it is found to be the most efficient fog signal yet known. The experience, however, with the most powerful fog signal is not at present to be considered altogether satisfactory. With Siren blasts absorbing about 150-horse power, or nearly five millions of foot-pounds per minute during the time they are sounding, the signal is occasionally not heard, under some conditions of fog and wind, beyond one mile, while at other times it is distinctly heard above ten miles. For marking shoals, channel fairways, and land falls, in positions where it is found to be impossible to erect a permanent structure, important service is rendered to the mariner by light vessels. The first of these aids to navigation was moored at the Nore in 1732. Her illuminating apparatus consisted of a small lantern provided with flat wick oil lamps, the latter unaided by optical apparatus of any kind. In 1807 the late Mr. Robert Stevenson, the eminent engineer of the Bell Rock Lighthouse, designed a larger lantern to surround the mast of the vessel, capable of being lowered down to the deck for trimming the light and raised when required to be exhibited. In 1872 the Trinity House increased the dimensions of their lanterns and reflectors for floating lights, the lanterns from 6ft. to 8ft. in diameter, with cylindrical instead of polygonal glazing, and the reflectors from 12in. to 21in. aperture, which improvements effected a ten-fold increase in the intensity of these lights. The present 8ft. cylindrical lanterns are just large enough to admit of the lamp-lighter entering them to manipulate the lamps. Further improvements have lately been made in the lamps, and some of these lights have an intensity in the beam of about 20,000 candles. In 1875 the first group flashing floating light, showing three successive flashes at periods of one minute, was exhibited from a new vessel moored at the Royal Sovereign Shoal, off Hastings. Since the above date this class of floating lights, showing two or more flashes in a group, has been considerably extended with advantage. In connection with this class of distinctive lights, I would here remark that, in the following year, a first order dioptric double flashing light apparatus, designed by Dr. John Hopkinson, F.R.S., for the Trinity House, and intended for the Little Basses Lighthouse, Ceylon, was exhibited at the Special Loan Exhibition of Scientific Apparatus at South Kensington. In a few cases the dioptric system has been adopted for light-vessels, but, so far, the catoptric system has been found to be most efficient for the special circumstances of a floating light. Up to the present, neither electricity nor gas has been tried as an illuminant for light-vessels, but an interesting experiment is now being made by the Mersey Docks and Harbour Board, with the electric arc light on board one of the light-vessels at the entrance to the Mersey. The difficulties attending the maintenance of an efficient floating light in some of the most exposed positions are great, and at times the service is a very arduous one to the men on board, yet any failure whatever is of very rare occurrence, and there is no instance on record of a British light-vessel having ever been deserted by her crew during a storm. Collisions, which unfortunately are of frequent occurrence, are probably the greatest source of danger to these vessels and their crews. Chinese gongs about 2ft. in diameter, sounded at short intervals, have been for many years the recognised standard fog signal of light-vessels, owing probably to their peculiar characteristic sound.

Many of the light-vessels of this country and other maritime nations are now provided with powerful Sirens or whistles, sounded by compressed air or steam. The question of utilising lighthouses and light-vessels as signal stations in telegraphic communication with each other, and connected with a central station for reporting arrivals, departures, casualties, and meteorological observations, has, for some time, received the consideration of lighthouse authorities generally, and, among the foremost in this direction as regards lighthouses, may be mentioned Canada, which has a large proportion of them so arranged. In Ireland the experiment is being made at Fastnet, a well-known exposed rock station off Cape Clear, where considerable difficulties have been experienced in defending the cable from the enormous wear and tear to which it is subjected at the submerged side of the rock. During the past year experiments have been in progress by the Trinity House, and I believe also by Germany, in the more difficult task of establishing telegraphic communication between a light-vessel and the shore. Off the coast of Essex the Sunk light-vessel has been so

[1] British Association, Birmingham Meeting, Address of Sir Jas. N. Douglass, President of Section G.

connected with the post-office at Walton-on-the-Naze, through nine miles of cable, and, although many difficulties are being experienced, and the system must prove costly, ultimate success is expected.

Very important accessories to lighthouses and light-vessels are buoys and beacons. Buoys built with staves of wood, and banded with wrought iron hoops, have been adopted for probably over a century, and are still used by all maritime nations; but they are being rapidly superseded by buoys constructed of iron or steel. In 1845 the first iron buoy was submitted to the Trinity House by the late Mr. George W. Lenox, and since that date very great improvements have been effected in the forms and construction of buoys generally, owing to the ease with which any desired forms and dimensions can be produced in iron and steel, as in shipbuilding. A very important improvement was introduced in iron buoys in 1853 by the late Mr. George Herbert, of the Trinity House, who suggested the raising up and hollowing out the bottom of buoys to about the level of the plane of flotation, and the attachment of the mooring chain at a point very near, but just below, the centre of gravity; he thus secured a more uniformly erect position of the buoy in a seaway and strong tidal current. The Herbert form of bottom is now generally adopted. Water-tight bulkheads were early employed with iron buoys for ensuring their safety. A modern iron or steel buoy may be, and often is, cut into by the stem of a steam vessel, or by her screw propeller, but is seldom caused to sink, its flotation being maintained by an uninjured water-tight compartment.

With the uniform system of distinctive individuality of these sea marks, which is now being rapidly adopted throughout England, Ireland, and Scotland, an important step has been taken towards identity of practice throughout the whole maritime world. In 1878 the successful illumination of buoys was accomplished by Messrs. Pintsch, with compressed oil-gas, and since then the system has been very considerably developed in this country and abroad, and thus these important aids to navigation are being rendered efficient by night as well as by day, thereby becoming more perfect accessories to lighthouses and light-vessels. The Pintsch gas buoys now in use are found to burn continuously for three to six months, according to size, without any attention. Neither oil nor electricity has yet been successfully applied to the lighting of buoys, but there now appears to be no reason why electricity from storage batteries should not be found efficient for the purpose at a reasonable cost. Automatic bell buoys, of various designs, and the Courtenay automatic whistling buoy are found to render important aid to navigation in fogs, but, unfortunately, none of these apparatus have at present that reliability which should be characteristic of a coast signal, and all such buoys should be used with caution, owing to their action being dependent on the motion of the sea surface. The remedy for this defect is a problem which has yet to be satisfactorily worked out. Until very recently a beacon was known to the mariner as a day signal only. Numerous structures, varying in form and dimensions, have for many years occupied prominent positions on shore and on rocks and shoals at sea, in all the maritime countries of the world, and some of these have been the work of considerable labour and cost. The iron beacon on the Wolf Rock, off the West Coast of Cornwall, completed by the Trinity House in 1840, and which in 1870 was replaced by the present lighthouse, required, before the days of steam tenders, five years to erect, and cost nearly £11,300. The recent successful lighting of beacons with automatic apparatus, in occasionally inaccessible positions, by electricity, compressed mineral oil-gas, and petroleum spirit, forms an important epoch in the history of lighthouse illumination. In 1884 an iron beacon, lighted by an incandescent lamp and the current from a secondary battery, was erected on a tidal rock near Cadiz. Contact is made and broken by a small clock, which runs for twenty-eight days and causes the light to show a flash of five seconds, followed by a total eclipse of twenty-five seconds. The clock is also arranged for eclipsing the light between sunrise and sunset. The apparatus is the invention of Don Isas Lavaden. In 1881 a beacon, lighted automatically by compressed oil gas on the Pintsch system, was erected in the river Clyde, and many other such structures have been erected in this country and the United States. In 1881-82 several beacons, lighted automatically by petroleum spirit on the system of Herr Lindberg and Herr Lyth, of Stockholm, were established by the Swedish lighthouse authorities, and are reported to be working efficiently. Last year a beacon lighted on this system, and another lighted by Pintsch's compressed gas, were erected by the Trinity House on the banks of the Thames, near Erith, and are found to be very efficient aids for the navigation of the river by night as well as by day. The petroleum spirit lamp burns day and night at its maximum intensity, and shows a white light with a short occultation at periods of five seconds. The occultations are produced by a screen, rotated around the light by the ascending current of heated air from the lamp acting on a horizontal fan. As there is no governor, the periods of occultation are subject to slight errors, but the gas beacon, which shows a white flashing light at periods of two seconds, is provided with a clock—specially designed for this beacon—which not only regulates with precision the flashes and eclipses, but also extinguishes the light a few minutes before sunrise and relights it just before sunset, a very feeble pilot light being left burning during daylight. Arrangement is made in the clockwork for a bi-monthly adjustment to meet the lengthening or shortening of daylight. These two lighted beacons are in the charge of a boatman, who visits them at least once a week, when he cleans and adjusts the apparatus and cleans the lantern glazing. These systems of lighted beacons are not yet sufficiently matured for forming a decided opinion as to their relative effciency and economy, but it may be considered certain that they will both be extensively adopted, because, in numerous cases, for the secondary illumination of ports, estuaries, and rivers, automatic-lighted beacons can be installed to meet fairly the local requirements of navigation at a fraction of the first cost and annual maintenance of a lighthouse with its keepers and accessories. In 1881 it was considered by the lighthouse authorities of this country that the time had arrived when it was absolutely necessary that an exhaustive series of experimental trials should be made on a practical scale for the exact determination of the relative merits—both as regards efficiency and economy—of the three lighthouse illuminants, electricity, gas, and mineral oil; which, by the process of natural selection, may be regarded as the fittest of all those at present known to science. After many unforeseen difficulties had been overcome this question of universal importance was, in July, 1883, referred by the Board of Trade to the Trinity House, who accepted the responsibility of carrying out the investigation.

The South Foreland station is especially adapted for lighthouse experiments generally, because of the existing facilities for observations on land and sea. The land in the neighbourhood has no hedges and few trees, and affords facilities for observations at distances of between two and three miles. The station is provided with surplus steam power for driving experimental machines for electric lights, and it is easily accessible from London. Three rough timber towers of sufficient strength to withstand, without tremor, the effects of heavy gales, were erected at the rear of the high lighthouse, 150ft. apart. These towers were marked in large letters A, B, and C. "A" tower was devoted to electricity, "B" to the gas system of Mr. Wigham, and "C" to such gas or oil lamps as might be proposed to, and approved by, the committee for trial during the experiments. A lantern of the usual first order dimensions, but with an additional height in the glazing for the passage of beams from superposed optical apparatus of the first order, was provided for each tower. The optical apparatus in each lantern was, in the outset, special in relation to the illuminant to be used for producing fixed and flashing lights. For the electric arc lights, optical apparatus of the second order of Fresnel was adopted, the apparatus having a focal distance of 700 mm. The dimensions of this apparatus are greater than optically required for the largest electric arc light yet tried for lighthouse illumination, but the internal capacity is found to be only just sufficient for the perfect manipulation of the light by a lightkeeper of possibly robust build. For the large gas and oil flames in the A and C lanterns, the apparatus adopted was of the usual first order size, having a focal distance of 920 mm. The lanterns were partially glazed on opposite sides—north and south—the southern arc being chiefly for observation from the sea. To the northward the land is better adapted for observations on shore, and here three observing huts were erected at the respective distances of 2144ft., 6200ft. and 12,973ft.; each hut was provided with accommodation for two watchers, and a chamber fitted with a large plate glass window in the direction of the experimental lights, and special apparatus for their photometric measurement. The third hut proved to be practically of but little value for photometry, the distance being too great; it, however, afforded an accurately known distance for eye measurements, and a barrack and starting point for watchers endeavouring to determine the vanishing distance of each light during hazy weather. In this they were further assisted by white painted posts, placed throughout the whole track to the experimental lighthouses, at distances of 100ft. apart, the distance of each post from the lights being plainly marked on it in black figures. For the more exact examination and measurements of the intensity of each luminary and that of the beam from each optical apparatus, a photometric gallery was erected in a convenient position, 380ft. long by 8ft. wide, and provided with all the necessary appliances. During a period of over twelve months the experimental lights were exhibited, and watched by numerous observers, trained and untrained, scientific and practical. During that period a vast amount of valuable evidence was collected; by the aid of which the committee were subsequently enabled to state their conclusions with definiteness. During these investigations intensities were shown in a single oil and gas luminary about three times greater than the electric arc luminary first adopted at Dungeness in 1861, while, with a single electric arc luminary, there was shown a practically available focal intensity about fifteen times greater than that of the Dungeness luminary, and the highest yet shown to be practically available for the service of the mariner. This fact demonstrated that the electric arc has the most important requisites of a lighthouse luminary; viz., maximum intensity and minimum focal dimensions, and in all states of the atmosphere from clear weather to thick fog, an incontestable superiority over the utmost accumulative efforts of its rivals—gas and oil. It was, therefore, considered to be unnecessary to incur additional cost for exhibiting the electric arc light, under the same conditions of accumulative powers as its rivals, for showing a maximum intensity. With the best gas and oil luminaries it was found that the question of merit between these illuminants was found to resolve itself into one of economy only, and in this respect mineral oil at the present market prices was found to have a considerable advantage. The general result of the photometric measurements of the three illuminants showed (1) that the oil and gas lights, when shown through similar lenses, were equally affected by atmospheric variation, (2) that the electric light is absorbed more largely by haze and fog than either the oil or the gas light, and (3) that all three are nearly equally affected by rain. Experiments made in the photometric gallery at the South Foreland with the electric arc light have shown that the loss by atmospheric absorption is by no means so great as was previously supposed. In 1836 Faraday showed by actual experiment that the penetrating power of a light in atmosphere impaired by such obstruction as fog, mist, &c., is but very slightly augmented by a very considerable increase in the intensity, and M. Allard, late engineer-in-chief to the French Lighthouse Board, has more recently shown, after long experimental and practical research, that in an atmosphere of average transparency a beam of light equal to 6250 Becs—Carcel—would penetrate 53 kilos., yet when augmented to twenty times that intensity, or 125,000 Becs—Carcel—it would only penetrate 75·40 kilos., showing that, in the average condition of atmospheric transparency, 2000 per cent. of increased intensity only gives 42 per cent. longer range.

The South Foreland experiments have demonstrated that while with both gas and oil an ordinary intensity of light can be adopted for clear weather, sufficient to reach the sea horizon with efficiency for the mariner, a maximum light can be shown with impaired atmosphere 15 to 20 times this intensity, and that in these respects both illuminants are practically on an equality.

With regard to the gas and oil lights, the report of the Committee states that: "It appears from the direct eye observations, made at distances varying from 3 to 27 milss in clear weather, that through annular lenses, light for light, there is practically no difference. Both reach the horizon with equal effect. In weather not clear the records indicate practically the same relation. In actual fog, again, the records indicate a general equality of the lights. Both are lost at the same time, both are picked up together, and although here and there a very slight superiority is attributed to the gas, this superiority is of no value whatever for the purposes of the mariner." The final conclusion of the Committee, on the relative merits of electricity, gas, and oil as lighthouse illuminants is given in the following words:—"That for ordinary necessities of lighthouse illumination, mineral oil is the most suitable and economical illuminant, and that for salient headlands, important landfalls and places where a very powerful light is required, electricity offers the greatest advantages."

In conclusion it may safely be asserted, now that the relative merits of electricity, gas, and oil have been accurately determined, that these investigations of the Trinity House Committee will, for many years to come, furnish to the lighthouse authorities of all maritime nations of the world, and their engineers, very valuable data, which cannot fail to assist very largely in the development of lighthouse illumination, and thus tend very materially to the present aids to navigation, and to a consequent reduction in the loss of life and property at sea.

CHEMICAL SECTION—ADDRESS OF THE PRESIDENT.

The address of Mr. W. Crookes, F.R.S., the President of this section, was one of great interest, especially to physicists and chemists. It dealt especially with the physics of the elements. We regret to be unable to give it at length. We can only indicate its character. Mr. Crookes attracted close attention as he developed "a few thoughts on the very foundations of chemistry as a science—on the nature and the probable, or at least possible, origin of the so-called elements"—views which may at first glance appear heretical, but in some respects shared more or less by not a few of the most eminent authorities, and notably by Dr. J. H. Gladstone, F.R.S.

"The first riddle which we encounter in chemistry is, 'What are the elements?' They take their stand, not on any attribute of the things to be defined, but on the limitations of human power. Just as to Columbus long philosophic meditation led him to the fixed belief of the existence of a yet untrodden world beyond that waste of Atlantic waters, so to our most keen-eyed chemists, physicists, and philosophers a variety of phenomena suggest the conviction that the elements of ordinary assumption are not the ultimate boundary in this direction of the knowledge which man may hope to attain. Soon after I had obtained evidence of the distinct nature of thallium, Faraday said to me: 'To discover a new element is a very fine thing, but if you could decompose an element and tell us what it is made of, that would be a discovery indeed worth making.' And this was no new speculation of Faraday's, for in one of his early lectures he remarked: 'At present we begin to feel impatient, and to wish for a new state of chemical elements. For a time the desire was to add to the metals; now we wish to diminish their number. . . . . To decompose the metals, then, to reform them, to change them from one to another, and to realise the once absurd notion of transmutation are the problems now given to the chemist for solution.'

"Mr. Norman Lockyer has shown, I think, on good evidence that in the heavenly bodies of the highest temperature a large number of our reputed elements are dissociated, or as it would perhaps be better to say, have never been formed. Mr. Lockyer holds that 'The temperature of the sun and the electric arc is high enough to dissociate some of the so-called chemical elements, and give us a glimpse of the spectra of their bases;' and he likewise says that 'A terrestrial element is an exceedingly complicated thing that is broken up into simpler things at the temperature of the sun, and some of these things exist in some sun-spots, while other constituents exist in others.'

"We ask whether these elements may not have been evolved from some few antecedent forms of matter—or possibly from only one such—just as it is now held that all the innumerable variations of plants and animals have been developed from fewer and earlier forms of organic life? As Dr. Gladstone well puts it, they 'have been built up one from another, according to some general plan.' This building-up, or evolution, is above all things not fortuitous; the variation and development which we recognise in the universe run along certain fixed lines which have been preconceived and fore-ordained. To the careless and hasty eye design and evolution seem antagonistic; the more careful inquirer sees that evolution, steadily proceeding along an ascending scale of excellence, is the strongest argument in favour of a preconceived plan.

"Many chemists must have been struck with certain peculiarities in the occurrence of the elements in the earth's crust; it is a stale remark that we do not find them evenly distributed throughout the globe. Nor are they associated in accordance with their specific gravities; the lighter elements placed on or near the surface, and the heavier ones following serially deeper and deeper. Neither can we trace any distinct relation between local climate and mineral distribution. And by no means can we say that elements are always or chiefly associated in nature in the order of their so-called chemical affinities; those which have a strong tendency to form with each other definite chemical combinations being found together, whilst those which have little or no such tendency exist apart. We certainly find calcium as carbonate and sulphate, sodium as chloride, silver and lead as sulphides; but why do we find certain groups of elements with little affinity for each other yet existing in juxtaposition or commixture? The members of some of these groups are far from plentiful, not generally or widely diffused, and certainly they are not easy to separate. A weighty argument in favour of the compound nature of the elements is that drawn from a consideration of the compound radicals, or, as they might be called, pseudo-elements. Their similarity with the accepted elements is perfectly familiar to all chemists. If, for example, we suppose, that in some age or in some country men of science were cognisant of the existence and of the behaviour of cyanogen, but had not succeeded in resolving it into its constituents, nothing, surely, would prevent their viewing it as an element, and assigning it a place with the halogens. Starting from the supposition that pristine matter was once in an intensely heated condition, and that it has reached its present state by a process of free cooling, Dr. E. J. Mills suggests that the elements, as we now have them, are the result of successive polymerisations. Dr. Mills reminds us that chemical substances in the process of cooling naturally increase in density, and, if such increase be measured as a function of time or of temperature, we sometimes observe that there are critical points corresponding to the formation of new and well-defined substances. From a study of the classification of the elements, Dr. Mills is of opinion that the only known polymers of the primitive matter are arsenic, antimony, and perhaps erbium and osmium; whilst zirconium, ruthenium, samarium, and platinum approximate to the positions of other polymers. Hence, from this genetic view, these elements may be described as products of successive polymerisations."

Mr. Crookes drew attention at great length to Professor Emerson Reynolds' method of illustrating periodic law and the Mendeleeff's series and said:—"The more I study the arrangement of this zigzag curve the more I am convinced that he who grasps the key will be permitted to unlock some of the deepest mysteries of creation. Let us imagine if it is possible to get a glimpse of a few of the secrets here hidden. Let us picture the very beginnings of time, before geological ages, before the earth was thrown off from the central nucleus of molten fluid, before even the sun himself had consolidated from the original *protyle*[1]. Let us still imagine that at this primal stage all was in an ultra-gaseous state, at a temperature inconceivably hotter[2] than anything now existing in the visible universe; so high, indeed, that the chemical atoms could not yet have been formed, being still far above their dissociation point. In so far as *protyle* is capable of radiating or reflecting light, this vast sea of incandescent mist, to an astronomer in a distant star, might have appeared as a nebula, showing in the spectroscope a few isolated lines, forecasts of hydrogen, carbon, and nitrogen spectra. But in course of time some process akin to cooling, probably internal, reduces the temperature of the cosmic *protyle* to a point at which the first step in granulation takes place; matter as we know it comes into existence, and atoms are formed. As soon as an atom is formed out of *protyle* it is a store of energy, potential—from its tendency to coalesce with other atoms by gravitation or chemically—and kinetic—from its internal motions. To obtain this energy the neighbouring *protyle* must be refrigerated by it,[3] and thereby the subsequent formation of other atoms will be accelerated. But with atomic matter the various forms of energy which require matter to render them evident begin to act; and, amongst others, that form of energy which has for one of its factors what we now call *atomic weight*. We must now be prepared for some such events as that the seven series of bands in the absorption spectrum of iodine may prove not all to emanate from every molecule, but that some of these molecules emit some of these series, others others, and in the jumble of all these kinds of molecules, to which is given the name 'iodine vapour,' the whole seven series are contributors.'

Summing up all the considerations he had reviewed, he said, "We cannot, indeed, venture to assert positively that our so-called elements have been evolved from one primordial matter; but we may contend that the balance of evidence, I think, fairly weighs in favour of this speculation. This, then, is the intricate question which I have striven to unfold before you, a question that I especially commend to the young generation of chemists, not only as the most interesting but the most profoundly important in the entire compass of our science. I say deliberately and advisedly the most interesting. The doctrine of evolution, as you well know, has thrown a new light upon and given a new impetus to every department of biology, leading us, may we not hope, to anticipate a corresponding wakening light in the domain of chemistry? I would ask investigators not necessarily either to accept or to reject the hypothesis of chemical evolution, but to treat it as a provisional hypothesis; to keep it in view in their researches, to inquire how far it lends itself to the interpretation of the phenomena observed, and to test experimentally every line of thought which points in this direction. Of the difficulties of this investigation none can be more fully aware than myself. I sincerely hope that this my imperfect attempt may lead some minds to enter upon the study of this fundamental chemical question, and to examine closely and in detail what I, as if amidst the clouds and mists of a far distance, have striven to point out."

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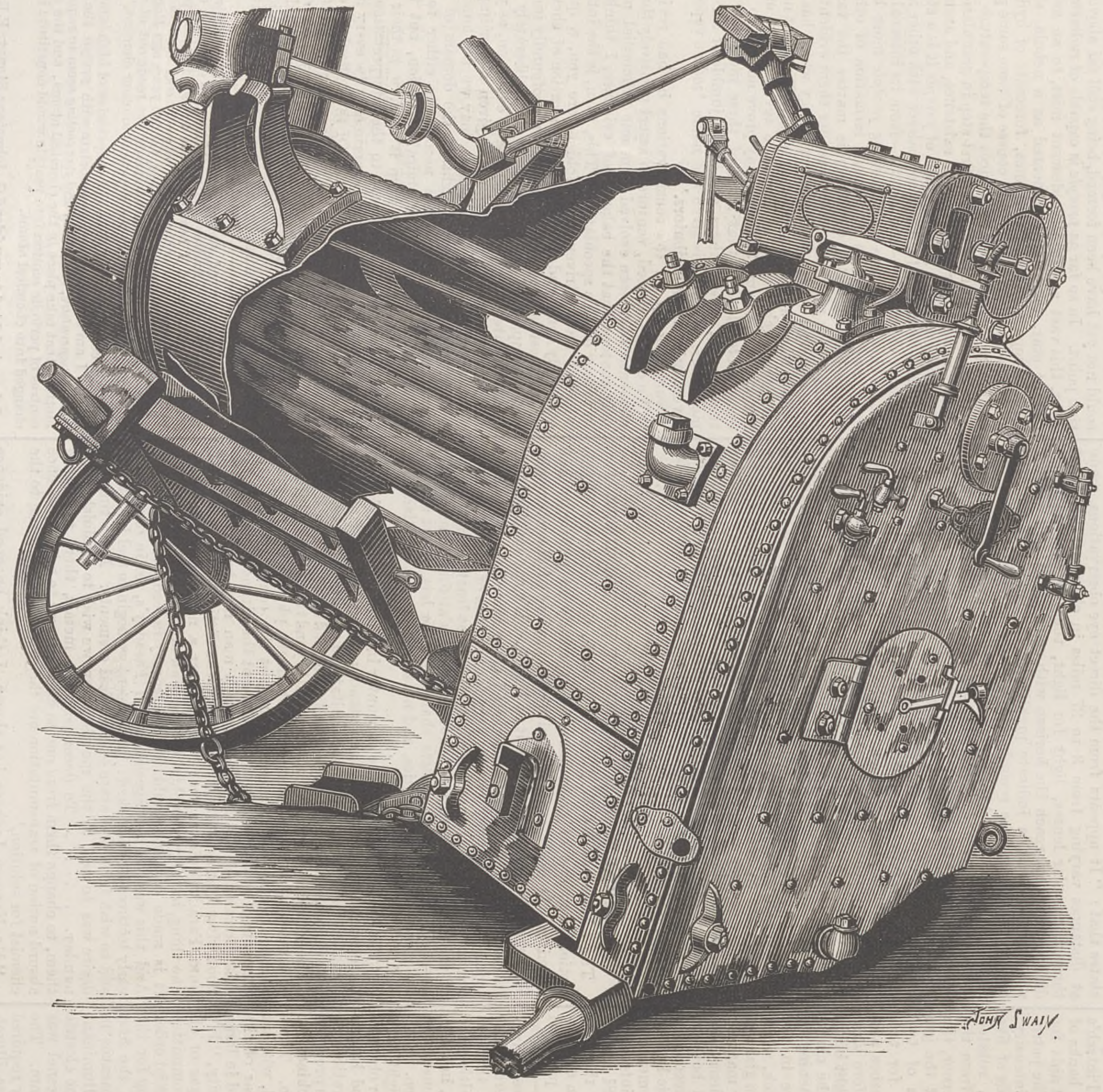
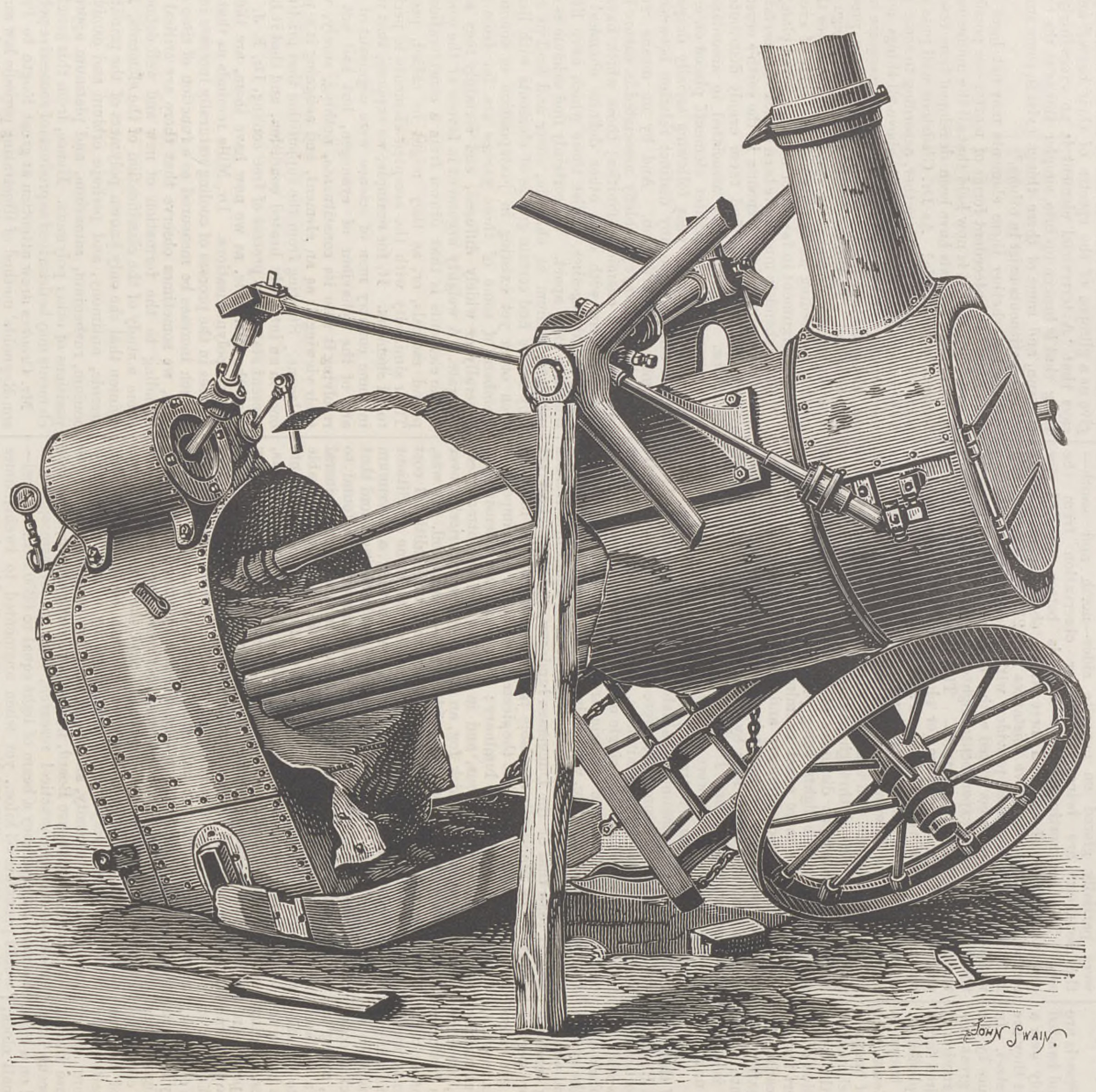
1 We require a word, analogous to protoplasm, to express the idea of the original primal matter existing before the evolution of the chemical elements. The word I have ventured to use for this purpose is compounded of προ—*earlier than*—and ὑλη—*the stuff of which things are made.* The word is scarcely a new coinage, for 600 years ago Roger Bacon wrote in his *De Arte Chymiæ*—"The elements are made out of ὑλη, and every element is converted into the nature of another element."

2 I am constrained to use words expressive of high temperature; but I confess I am unable clearly to associate with *protyle* the idea of hot or cold. *Temperature, radiation*, and *free cooling* seem to require the periodic motions that take place in the chemical atoms, and the introduction of centres of periodic motion into protyle would constitute its being so far changed into chemical atoms.

3 I am indebted to my friend G. Johnstone Stoney, F.R.S., for the idea here put forward, as well as for other valuable suggestions and criticisms on some of the theoretical questions here treated of.

EXPLODED PORTABLE ENGINE BOILER, STOW, MIDLOTHIAN.





A PORTABLE BOILER EXPLOSION.

We fancy that the accompanying engravings will interest our readers. They are copied from an official report made under the Boiler Explosion Act of 1882 by the Board of Trade.

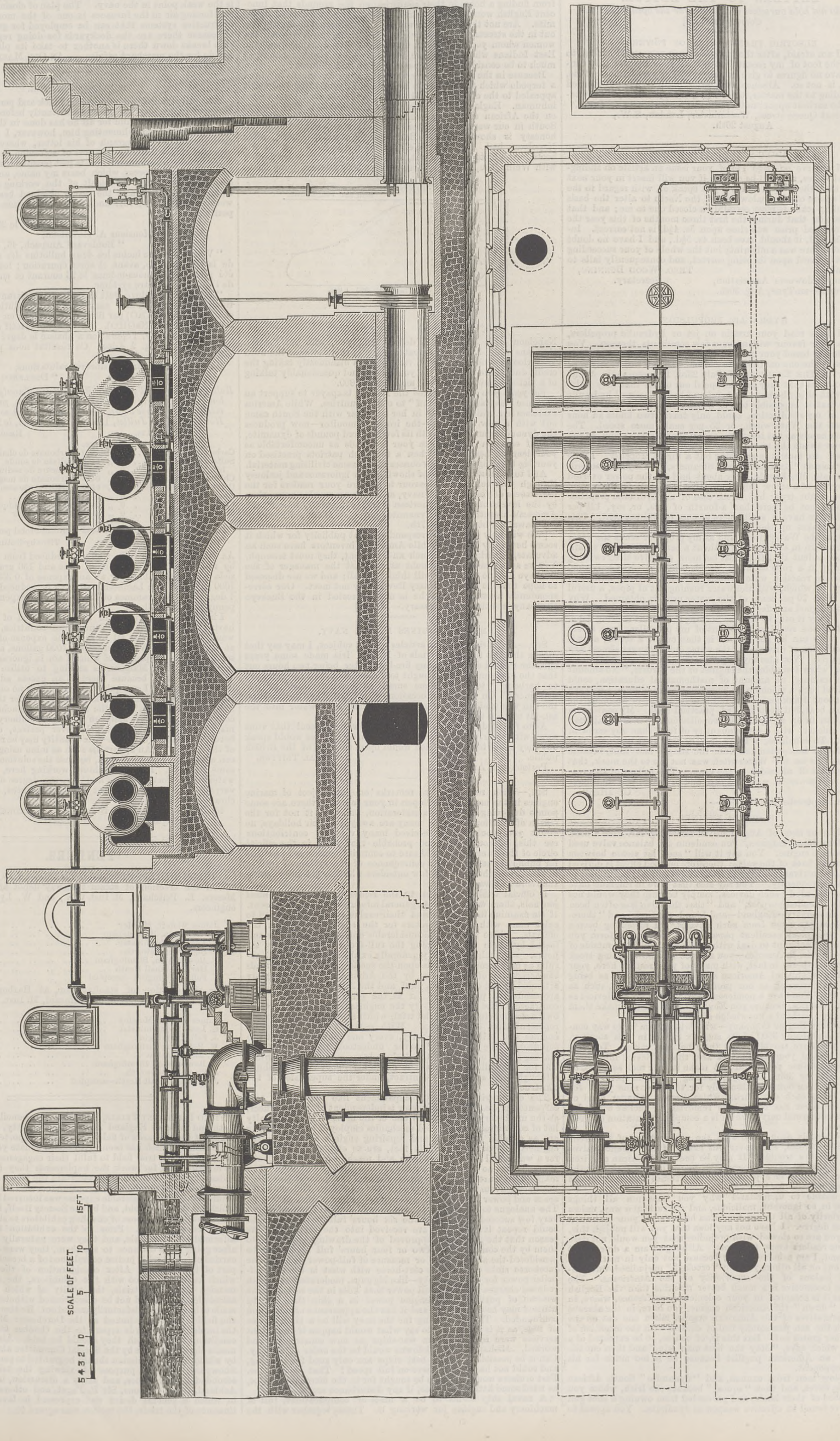
The explosion occurred at 4 p.m. on the 20th of May, at the Station Saw Mill, Stow, Midlothian. The saw mill belongs to Messrs. George and John Brown, George Brown being the managing partner, and also attending to the boiler and engine. No person was killed or injured. This was a portable engine and boiler of the usual agricultural type, the boiler being of iron and single rivetted throughout. Length of boiler over all, 9ft. 9in.; length of barrel, 6ft. by 2ft. 6¾in. internal diameter, composed of two plates $\frac{5}{16}$in. in thickness with longitudinal lap joints, the rivets being ¾in. diameter spaced 2in. apart, and the width of the laps 1⅝in., the joints being at the top and bottom of the barrel. Fire-box, length, 1ft. 8½in.; width, 2ft. 5in.; height, 2ft. 10in. Fire-box casing, length, 2ft. 4in.; width, 3ft. 1in.; height, 4ft. 3in.; of ⅜in. plates, the two being joined at the bottom with an N iron. Fire-box stays ⅞in. diameter, spaced 6in. by 6in. Top of fire-box stayed with three T-iron girders, each 3⅜in. by 3in. by ½in. The girders are rivetted to the crown plate with four ¾in. rivets, passing through thimbles ¾in. in thickness, and the ends of the girders bent downwards ¾in. to form feet. There are also two longitudinal stays ⅞in. diameter in the steam space. The tubes are 2¾in. external diameter and 26 in number, but none of these are stay tubes. The whole of the fittings were in good working order. Clayton, Shuttleworth, and Co., engineers, Lincoln, is inscribed on the name-plate. The engine was bought by the present owners on the 23rd December, 1884, from Messrs. Graham and Co., Dobbies-lane, Glasgow. Mr. Graham has no record of the person he bought it from or date of purchase, neither does he know the age of the boiler. There is no number on the boiler or engine, and not even a letter, number, or mark on any of the working parts of the engine by which its history might be traced. The fire-box casing had been patched, and new fire-box stays fitted at some time. No repairs have been done to the boiler since Messrs. Brown bought it; but some small repairs have since been made to the engine. Mr. Jas. Thomson, millwright and engineer, Stow, made an external examination of the engine and boiler and also tried it under steam at 70 lb. pressure at the time Messrs. Brown bought it. Mr. Thomson has also seen the doors off once since that time, when making repairs to the engine. The boiler was not insured.

The engine was stopped a few minutes before the explosion, when the steam pressure is stated to have been 40 lb. The barrel of the boiler was rent from end to end at the bottom, and torn from the fire-box casing; it is also torn circumferentially, immediately abaft the saddle plummer blocks of the engine and the wrought iron bracket plate for attaching the front wheels. This portion of the boiler was separated into two main and several small pieces, some of which were blown through the roof of the shed into the adjoining field. The throat plate was torn in shreds from the fire-box casing and stays. One longitudinal stay was broken. The front tube plate was torn from the angle iron ring at the bottom, and the bottom tube ends were started. The engine and carriage were broken in pieces, and the wooden shed was demolished. Fortunately, all the men were employed a little distance off at the time of the explosion, and so escaped injury.

This explosion was due to grooving and wasting at the edge of the inside lap of the bottom longitudinal joint, the plate being reduced in thickness throughout the whole length of the barrel from a maximum of $\frac{3}{16}$in. down to $\frac{1}{32}$in. and under, until it was unequal to sustain the load due to the ordinary working pres-sure of 50 lb.

The barrel was encased with sheet iron over wooden lagging, which was not removed to examine the shell externally when Messrs. Brown bought it. Neither were any of the tubes removed to examine the shell internally, both of which should have been done to make an efficient examination. The simple precaution of testing with water pressure was not even taken. The boiler and engine were tested with a little extra steam pressure, and this proving satisfactory, all was thought to be well; but at the same time this serious grooving must have existed in the barrel. In the opinion of Mr. Lewis, the Board of Trade inspector, the grooving must have commenced years ago, and it is a long time before such grooving becomes dangerous. Judging from experience in the investigation of three explosions of boilers of the same type, and due to the same cause, it is found that the grooving action is not generally very rapid, and that proper periodical examination would not fail to discover it. With the exception of this grooving, the boiler was in fairly good condition, and would have worked for years longer.

A New Channel Steamer.—The new Channel steamer Victoria, running in connection with the London, Chatham, and Dover Railway between Dover and Calais, was put on the station last Sunday. She has made the quickest passage on record.



PUMPING MACHINERY.—ALEXANDRA DOCKS, HULL.

MESSRS. GWYNNE AND CO., LONDON, ENGINEERS

(For description see page 195)

LETTERS TO THE EDITOR.

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

ELECTRIC TRANSMISSION OF POWER.

SIR,—I am afraid, after the invitation you were good enough to place at the foot of my recent letter, that your readers may consider I have no figures to give in support of my assertions. This, however, is not so. Absence and other matters have prevented me attending to the matter, but I will avail myself of your invitation at the earliest opportunity. RADCLIFFE WARD.

10A, Great Queen-street, Westminster, London, S.W.,
August 26th.

SLIDING-SCALES AND WAGES.

SIR,—I observe on page 114 of your issue an article on sliding-scales and wages, and will be obliged if you will insert in your next number that the "open secret" you speak of, with regard to the proposed action of the coalowners of the North to alter the basis of the sliding-scale, is most certainly a closed one to me; and that your assertion that during the first three months of this year the average realised price was close upon 5s. 4½d. is not correct. Instead of 5s. 4½d. it should have been 4s. 5½d., and I have no doubt the former figure was a misprint; but the whole of your succeeding argument is based upon its being correct, and consequently falls to the ground. THEO. WOOD BUNNING,

Durham Coalowners' Association, Secretary.
Newcastle-on-Tyne, Aug. 30th.

HYDRAULIC PROPULSION.

SIR,—I have read your article on jet or hydraulic propellers, and with your favour will make a few comments thereon. You have evidently based your calculations as to the efficiency of these propellers by the one on the Waterwitch. If you will kindly read my letter in THE ENGINEER of July 23rd, I therein said: "The wonder to me is that they got the speed out of her that they did." And yet with this, the most wasteful and badly-designed hydraulic propeller that it is possible to use, a sister twin-screw gunboat, to the best of my recollection, could only travel two knots an hour faster than the Waterwitch, or 25 per cent. more speed. The waste even here was not ten times as much as a screw; and, as you say, a screw twists the water up in a rope, and has various other drawbacks. In fact it is anything but a direct propeller. I note in your article on "Express Atlantic Steamers," you say that, according to the late Mr. Froude, only about half of the power exerted by the engines of a screw ship is effective in propelling the vessel. This is no doubt true; but in the case of my hydraulic propeller there would not be more than a-fourth of this, or, say, 12½ per cent. Thus we have a saving here at once of 37½ per cent. This more than makes up the 25 per cent. by which the twin-screw gunboat beat the Waterwitch; and as my propeller sends the water out at the stern in a direct line without a bend in the pipes at all, it must be evident that this must be more effective than twisting the water up in a rope before it propels it astern. Not only this, but there are reaction water-wheels at work, driving mills and machinery, by which, with the water rushing out of pipes, a useful effect of 60 to 70 per cent. of the water used is obtained. Why should not as good an effect, if not better, be obtained in propelling a vessel? I say it can, as there is nothing to prevent it being done. In regard to the speed to be got out of my propeller, I can safely say that more can be got out of it than out of a screw, as it is simply a question of driving out the water quicker to get almost any speed required. You also say in your article on "Express Atlantic Steamers," when describing the engines of the Etruria, "No amount of college training, no amount of mathematical education, could have evolved such a machine." This being your opinion, I will say nothing about Rankine, or the recoil of the gun, or dropping the sacks into a boat, but keep to hard, practical facts. My contention is this: I can fit up an hydraulic propeller on any vessel that shall drive her quicker, with a given quantity of fuel, than any screw in existence. To conclude, I think it very hard that hydraulic propulsion should be condemned from the simple fact that, because the crude affair on the Waterwitch was not up to the mark, that all others must of necessity be the same. The fallacy of this reasoning I will prove as soon as I can, and of which you shall have due notice. GO-AHEAD.

London, September 1st.

BUCKEYE ENGINES.

SIR,—In your issue of August 6th in reviewing Mr. Rose s book on "Modern Steam Engines," you condemn the balance valve used in the Buckeye engine. You say it will "soon let steam between the piston and back of the valve; therefore no good effect is derived by using the contrivance, unless indeed it is taken apart and examined and adjusted frequently." You say also that "we in England have long since discarded 'such devices,' simply because they would not answer the intended purpose," and "that this plan has often been tried in this country—England—and found wanting," and "therefore no good can come from such devices." I have long been a reader of your most excellent paper, but I desire to inform you that when you attempt to deal with mechanical subjects outside of England—that is, in America—you at once become laughing stock for your readers here; in fact, with many of your readers here, your paper, when treating of American subjects, is looked on as being as funny and amusing as our professional funny papers, such as "Puck," &c. You have a ponderous way of condemning devices as failures in America, because you English have failed to make them successes, and without a knowledge of the facts.

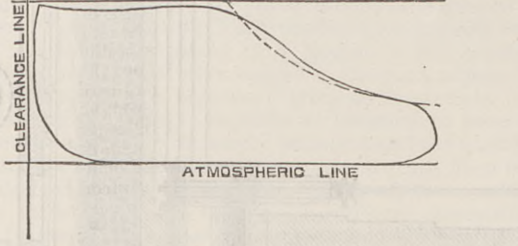
The Buckeye Engine Company—with which I am in no way connected—has probably 3000 of its engines in use in this country, and they never are troubled with their balance valves. To show you how absurd your conclusions are, that a device must be a failure here because you could not make it go, I took some cards from an 18in. by 36in. Buckeye, making 110 turns per minute, which it has been doing continuously for the past nine years for eighteen hours each day, during which time a cylinder head or steam chest cover has never been removed. I enclose copy of a card with isothermal curve, which is a complete refutation of your conclusions.

I am personally acquainted with the performance of hundreds of Buckeye engines, and never yet heard of the balance valves giving a minute's trouble. It may be because American cast iron is better suited to this purpose than yours, or the fact that the valves are scraped to a joint under the steam pressure they are run at may account for it.

I am unable to understand why you condemn all things American in so ignorant, malicious, and untruthful a way, unless the superiority of all things American has affected your brain in a dangerous degree. I have not any idea that you will publish this, because you are so slewed with prejudice that you would not dare to let your readers know the facts. Although I am a descendant of Scotland, I am ashamed of it, because not only in mechanical subjects but on all others you are "crooked," prejudiced, untruthful, and jealous of the superiority of the Americans. The American locomotive is a much better machine than the English engine, as it is accepted in your colonies in preference, where, in order to "down" the American engine, you have, in the absence of representatives of the American engine, taken one out on the road with the ash pan solidly full of cinders with the intention of burning her grates out. But this is, of course, to be expected of a country which says, "May the best man win," and then cut the ropes of an American pugilist because he is too much for his English opponent.

You blow men from cannon, and "dynamite" South African negroes in caves, and then "squeal" because the Irish, whom you have robbed of their lands, and prevented from owning a shot gun even, have found an effective weapon in dynamite. You appeal to the civilised world to assist you in preventing the Irish dynamiters from finding a home in their countries, on the grounds that innocent English women and children are often the victims of dynamite. Are not the poor Irish women and children who are thrown out in the streets to starve by your landlords, the South African women whom you have blown up in caves with dynamite, and the East Indians whom you have humanely blown from cannons, as much to be considered as your own women and children?

Because in the revolutionary war one of the Americans invented a torpedo which threatened to be successful, your valiant admirals appealed to the civilised world to the effect that such means were inhuman. England, the "bulwark of Christianity," kept cruisers on the African coast to prevent slavery, and then sided with the South in our war. "Consistency, thou art a jewel." Your dishonesty is shown in the Battle of Waterloo, where, after Napoleon had thumped Wellington, until he shook in his boots for night to help him out, and when the Germans combining with Wellington, making a force of some 200,000 men, jump on to



Napoleon with 80,000, and defeat him, you, who but for the Germans would have been defeated, have to this day used the word Waterloo as synonymous with victory, thus dishonestly taking the credit due to the Germans to yourselves, and questionably talking of a victory gained by 200,000 men over 80,000.

For years you have beggared the English taxpayer to support an immense Navy as a big "bluff" to other countries. While America exercises her brains, and as in her own war with the South came out with a new invention—the ironclad monitor—now produces the dynamite gun, which, with its few hundred pounds of dynamite, will, if occasion arises, make your ironclads as uncomfortable as your dear old London was when a few Irish patriots practised on your big buildings with a few ounces of the same civilising material.

And to conclude, in place of showing your ignorance and jealousy through your columns, endeavour to prepare your readers for the uselessness of your ironclad navy, as was your wooden navy, then by the invention of an American ironclad monitor, now by the American invention of the dynamite gun. HARRY REVRIE.

Delaware, Ohio, August 17th.

[We willingly give our correspondent that publicity for which it seems he hardly hoped. While American inventors have such an advocate, American ideas such an exponent, they must triumph. Yet we are agitated by a doubt as to what the manager of the Buckeye Engine Company will think of it all; and we are disposed to hope that he and Mr. Harry Revrie may not meet. Our correspondent's assurance that he is not interested in the Buckeye Company is entirely unnecessary.—ED. E.]

MARINE ENGINES IN THE NAVY.

SIR,—As bearing on your articles on this subject, I may say that during the first full-speed trials of H.M.S. Iris made some years ago, she melted down so many fire-bars after being two hours out that the experiment was brought to a conclusion, and she returned to harbour "to have some small adjustments made in her machinery." On the second occasion, with heavier and deeper bars, the run was made by firemen throwing buckets of water into the ash-pit to keep the bars cool.

As to forced draught, no one knows how much coal that runs away with in driving the fans. If some of my mates would speak out they could tell a lot which would open the eyes of the British public. TRIAL TRIPPER.

Portsmouth, August 31st.

SIR,—With regard to the remarks on the subject of marine engines in the navy touched upon in your columns, there are some points deserving of great consideration, and were it not for the season of vacation, when so many are away for their holidays, no doubt you would have received many valuable contributions ere this, although it is not probable that those in the official circle of the Admiralty would care to commit themselves to writing for public discussion, and in consequence of the system of reserve in the service there are but few outsiders who can get information that is in any way reliable.

If official trials were open to the representatives of technical journals, there would be more general information than at present. If we examine into the cause of their exclusion, it will be found to exist more with the contractors for the engines than with the officials. There is always a considerable amount of anxiety manifested by them when running the full-speed official trial of six hours. So much uncertainty generally exists as to successful results as may account for it, as upon the success of this trial depends the acceptance of the engines by the Admiralty. The trials are attended by the contractor's staff and the Admiralty officials, and are conducted privately as far as the press is concerned. The contractors raise steam and try the engines several times on their own account before the official trial, which should be open to the representatives of the press. With regard to the efficiency of engines and boilers in the navy, every one knows the best are supplied. The Admiralty never undertook the designing or making marine of engines; the dockyards are simply for repairing. But for shipbuilding the case is different. They do build ships, although some are built by contract, under the supervision of the constructor.

The engineering becomes a department like the rigging and carpentering &c. The constructor is independent of the engineer, as the machinery is supplied by one of the firms on the Admiralty list of contractors; the skilled mechanics employed in shipbuilding are as capable of making and repairing engines as those in the engineer's department, and, in fact, are so employed sometimes, for a war vessel is full of engines and machinery. It is said the Warspite has no fewer than eighty-seven cylinders on board. The main engines are frequently fine specimens of marine engineering, but in endeavouring to comply with the conditions laid down for space and power frequent departures from ordinary rules are made. The analogue to the racehorse may be well applied to naval ships; very few succeed in running the six hours' full-speed trial, none could repeat it; yet they are received into the service for the reason that the Admiralty approved of the drawings submitted to them by the contractors. Two or four hours' full speed may be considered the average run or measure of full-power trials. The racehorse sinks down to the cart-horse with what is termed half-boiler power for ordinary duty—like big guns, moderately safe with reduced charges. It is the full power that kills in the service; the wisdom of putting more engine power in a ship than can be utilised may be questioned, and it has the appearance of confusion confounded. The next thing for the navy will be a large service of tugs, as it is impossible to say what would happen if important services were required from war-ships as now constructed and worked. Mishaps and breakdowns would be the order of the day. Can it be possible that our best ships are only good for spurting, and could not hasten anywhere on full speed? That is the case. Fast cruisers would have to be sought for in the merchant service, as tried some little time since, if any disturbance arose.

A naval ship seems to be a mass of complications, full of machinery and engines for working it. These, together with the main engines, tax the boilers to the utmost to supply steam. Here is the weak point in the navy. The plan of closing the stoke-holes and forcing air to the furnaces is one of the most precarious and destructive systems that can be employed for generating steam. Of course there are the dockyards for doing repairs, and if one ship breaks down there is another to take its place. This would not do for the merchant service. AN OLD MARINE ENGINEER.

London, August 30th.

SOFTENING WATER.

SIR,—Everyone must admire the pluck and perseverance of Mr. Maignen in keeping his process constantly before the public, and great credit is due to him for all he has done in the purification of water. Besides complimenting him, however, I must take exception to the last paragraph of his letter, where he says, "It is expected this will reduce the cost of softening to half that of any other process in existence." It is just possible that Mr. Maignen is ignorant of the process which bears my name, and as I take it as such, I will give him the result of the working of my process at Lille. I could add also the result obtained here by the waterwork's engineer, but this and other information I hold at his disposition.

"Lille, le 29 Juillet, 1886.

"Monsieur A. Howatson,
"Boulevard Anspach, 46, Bruxelles.

"Vous trouverez inclus les deux bulletins des analyses de l'eau de la ville de Lille, avant et après épuration; les échantillons ont été prélevés par nous-mêmes le 26 courant et en marche normale de l'appareil de votre système.

"Le réactif employé était l'eau de chaux titrant 180 deg. hydrotimétriques, c'est-à-dire contenant en dissolution 1 gr. 026 de chaux caustique (CaO) par litre, et contenant en outre 0 gr. 25 de soude caustique (NaOHO). La dose de réactif étant de 12 litres par 100 litres d'eau, l'épuration a abaissé le degré hydrotimétrique de l'eau de 30 deg. à 4 deg. Ce résultat nous paraît tout à fait satisfaisant.

"Agréez, Monsieur, nos sincères salutations,
"DECLERCQ AND GODINE.

Bulletin d'analyse d'un échantillon d'eau prélevé par nous-mêmes à son entrée à l'appareil Howatson, le 26 Juillet, 1886.

RESULTATS.

	Par litre.
Carbonate de chaux ..	0 gr. 2640
Sulfate de chaux	0 ,, 0425
Id. de soude	0 ,, 0080
Chlorure de sodium ..	0 ,, 0455
Carbonate de magnésie	0 ,, 0160
Alumine et fer	0 ,, 0080
Silice..	0 ,, 0030
Matières organiques ..	0 ,, 0560
Résidu total par litre	0 gr. 4430

Titre hydrotimétrique 30 deg.

Bulletin d'analyse d'un échantillon d'eau prélevé par nous-mêmes à sa sortie de l'appareil Howatson, le 26 Juillet, 1886.

RESULTATS.

	Par litre.
Carbonate de chaux ..	0 gr. 0290
Sulfate de soude	0 ,, 0524
Chlorure de sodium ..	0 ,, 0450
Carbonate de magnésie	0 ,, 0100
Id. de soude ..	0 ,, 0080
Silice	0 ,, 0030
Matières organiques ..	0 ,, 0310
Alumine et fer	0 ,, 0110
Résidu total par litre	0 gr. 1894

Titre hydrotimétrique 4 deg.

As will be seen, the Lille water is reduced from 30 deg. to 4 deg. by the use of 558 grammes of lime and 136 grammes of caustic soda per 1000 gallons, or at an expense of 0·358 of a penny per 1000 gallons. The Lambeth water can be reduced from 14 deg. to 4 deg. with 363 grammes of lime, or at an expense of 0·085 of a penny per 1000 gallons.

I have little experience in the purification of English waters, having confined myself to Continental countries, and no doubt it would be of interest to all to know the expense of the anti-calcare at the Vauxhall Waterworks per 1000 gallons, as there may be some secret in his process of which I am in ignorance. It seems to me that if Mr. Maignen is seeking to utilise the precipitate or sediment it is because there is an excess added in the first instance, and this I can quite understand, as no one can depend on the quality of the lime—one kind may be richer than another, and it is impossible even with the most perfect machinery to insure a constant supply. Mr. Maignen says his machinery is perfect; that may be, but no machinery, however perfect, can discriminate between good and bad lime—the quantity may be regular, but what of the quality? An apparatus such as mine using lime in solution can always be depended upon, because the solution is always of the same strength. I have machines working here, notably at the waterworks, working night and day, the degree of hardness never varying. As to the first cost of my apparatus, it is by far the cheapest in the market.

46, Boulevard Anspach, Brussels, ANDREW HOWATSON.
August 30th.

TENDERS.

BIRMINGHAM CENTRAL TRAMWAYS COMPANY.

FOR the erection of steam tramway depôt at King's Heath. Messrs. E. Pritchard, M. Inst. C.E., and W. Lyster Holt, C.E, engineers.

	£	s.	d.
James Moffatt, Moseley	6512	0	0
W. Robinson, Birmingham	6150	0	0
G. Law, Kidderminster	6077	0	0
J. Biggs, Handsworth	5578	6	0
F. Rowbotham, Birmingham	5549	0	0
J. Hartley, Small Heath	5379	0	0
J. Fell, Leamington—accepted	5150	0	0

For the erection of stabling, &c., at Harborne. Messrs. E. Pritchard, M. Inst. C.E., and J. Kincaid, M. Inst. C.E., engineers.

	£	s.	d.
James Moffatt, Moseley	5157	0	0
G. Law, Kidderminster	4613	0	0
J. Fell, Leamington	4600	0	0
W. Robinson, Birmingham	4482	0	0
W. Bloore, Asten	4397	0	0
F. Rowbotham, Birmingham	4290	0	0
J. Biggs, Handsworth	4263	9	6
J. Hartley, Small Heath—accepted	3948	0	0

FIELD IMPLEMENT TRIALS.—At the last council meeting of the Bath and West of England Agricultural Society, Mr. Knollys, on behalf of the stewards of field implements, reported that, owing to the difficulty which has been experienced of late years in inducing exhibitors in the trial field to fulfil their engagements with respect to bringing out for work the implements they had entered, an endeavour had been made to ascertain the views of the exhibitors themselves with regard to the continuance of these trials. It was pointed out that considerable expense was incurred by the locality in which the show was held, and by the Society itself, in providing land and crops for the purpose of enabling exhibitors to show their several implements at work. Prior to the exhibition the public were informed of these trials, and they were naturally disappointed if, after going some distance to see them, they were only imperfectly carried out, and with justice complained of a breach of faith on the part of the Society. After consideration of the correspondence which had taken place with the exhibitors, the stewards recommended that these trials, the utility of which had been often acknowledged, should not be discontinued without an effort being made to have them satisfactorily carried out. He therefore moved that the field trials be continued at the Dorchester Meeting, and that the implement stewards report to the October Council as to the conditions under which they should be held. Also, that arrangements should be made by the Special Committee already appointed, by which free re-admission should be granted to persons leaving the Showyard, for the purpose of viewing the trials. This was seconded by Mr. Jones, and after a discussion, in which Messrs. Ackland, Gray, Gibbons, Sir R. Paget, and others took part, and in which a general desire was expressed in favour of the continuance of the trials, the motion was agreed to.

RAILWAY MATTERS.

THE Victorian Government has, *India and the Colonies* says, decided to ask Parliament to vote £300,000 for the immediate purchase of new rolling stock and locomotives for the Victorian railways.

THE report of the Waterford and Limerick Railway Company for the past half-year gives the number of miles worked by the company's engines as nearly 272, and the train mileage as 417,419, of which 357,591 is of passenger and mixed trains and 59,828 of goods and cattle. The cost of maintenance of way and works was £16,275 8s., and of locomotive power £12,448 17s.; of the latter £3757 17s. was for coal and coke.

THE four Swiss cable railways, 0·1 mile, 0·2 mile, 0·37 mile, and 1·12 mile long respectively, were all worked in 1844 for about 45 per cent. of their gross earnings, but the returns on the capital varied from 1·42 to 17·25 per cent.; the latter, with the shortest road, only 530ft. in length, which cost but £3011, has but two cars, is worked by a force of six men, and gets about 5c. apiece for carrying a passenger up or down. The longest of these roads, which runs ninety-five trains a day, and carries an average of 1328 passengers daily—Lausanne to Ouchy—made a profit of £2672, but, the *Railroad Gazette* says, it cost £136,101.

THE heaviest passenger traffic in Switzerland in 1884 was on the Bödeli Railway, where it was equal to 225 each way daily, while on another it was only 35½; the heaviest freight traffic was only equal to 103 tons each way daily, while the lightest was only 6 tons. The little Rigi Railway (mountain), earned £2938 per mile from passengers, receiving 21⅝c. per passenger per mile. The total earnings of the Rigi were £3223 per mile, while the highest on any ordinary railway were £2399. One ordinary railway collected an average freight rate of 11c. per ton per mile, the Rigi getting 4s. 3d. per mile for taking a ton up or down the mountain. The cost of working the Rigi was £2160 per mile, leaving £1063.

ALTHOUGH there was a substantial reduction in the working expenses generally, there was a considerable addition made to the rolling stock of our railways during 1885. Of locomotives the number increased from 14,827 to 15,196, an increase of 369; of passenger vehicles an increase from 33,031 to 33,658, an increase of 627; and of goods wagons, an increase from 454,945 to 464,153, an increase of 9208. Working expenses absorbed the same percentage of the gross receipts in 1885 as in 1884—that is, 53 per cent. The amount of Government duty paid in 1885 was £343,456, or about £55,000 less than in the previous year, a fact which points clearly to the increase in the proportion of cheap travel. Compensation for personal injuries has fallen from £183,657 in 1884, to £128,010 in 1885, and there has also been a reduction of about £20,000 in the amount paid as compensation for damage or loss of goods.

IN the United States they are adopting the European fashion, and fitting tail rods to the pistons of their locomotives. The shops of the Great Western Division, Grand Trunk, in Hamilton, Ont., are now building some heavy passenger engines. The engines have 6ft. drivers, and 19in. by 24in. cylinders. In order to give proper support to the piston, and prevent it dragging on the bottom of the cylinder, the piston-rod is prolonged through the front cover, and therefore supported at each end by suitable bushes and glands. "The result of the experiment on the Great Western will be awaited with considerable interest," we are told. We do not see what there is to wait for. The plan works very well in practice. Locomotives run with certainty, and keep the track, and maintain their speed, even when fitted with tail rods. In fact, as far as is known, the presence or absence of tail rods makes no difference whatever; at least, that is the verdict of English locomotive superintendents. But, of course, their views are not of much account, as they really do not know how to build locomotives. Even moderate perfection in that class of work exists, as is well known, only in the United States.

A RUSSIAN Commission appointed to test rails and tires found:—(1) Tires from soft steel are more brittle—liable to break—than hard steel ones. (2) Tires from soft steel wear much more rapidly than hard ones, and are not to be recommended (3) Very hard steel is bad in use, and requires frequent turning up. (4) The best tires contained more carbon and much less manganese than the less excellent, 0·5 per cent. against 0·37 per cent. for carbon, and 0·37 per cent. against 0·76 for manganese. The proportion of silicon to phosphorus is pretty constant in the best tires. The commission recommended changes in the imperial regulations for rail-testing, looking to the retention of the bending and drop-tests, the former only within the elastic limit, the latter to be tried both with chilled—reduced to freezing temperature—rails and warm ones, with a reduction of the height of fall and omission of a second drop. Each charge is to be tested for the above by taking one rail out and testing it in three pieces separately. In addition, tensile and chemical tests are to be made periodically during delivery, for which limiting figures are set for strength and amount of injurious element, silicon, manganese and sulphur. For tires the drop test is to be reduced and the tensile test retained.

IT is said that there appears to be a great probability that the proposed tunnel under the Straits of Messina will be constructed, the Italian Minister of Public Works having instructed the engineer, Carlo Navone, to carry on investigations on the basis of the plans prepared by the engineer Gabelli. The latter brought the subject before the Italian Parliament as early as 1879, and in 1882 he delivered a lecture at Rome, in which he dwelt upon the necessity of joining the railways of Sicily and Southern Italy both for commercial and military reasons, and demonstrated the practicability of the undertaking from a scientific point of view. According to Professor Seguenza, of Messina, a geologist, the formation of the strata under the straits is favourable to the construction of a tunnel. Its cost is estimated by Gabelli at £2,840,000, and the time of construction at from 4½ to 6½ years. The tunnel would have to be made about 500ft. below the level of the sea, this depth to be reached by spiral approaches from the land ends. Its total length would be about 8½ miles. There is an alternative proposal for joining the island of Sicily with the Italian mainland by means of a bridge thrown across the Straits of Messina, which is about eight miles wide at its narrowest part. Whichever scheme is adopted there seems to be no doubt that the closer connection of the island with Italy is much wanted. Sicily has made great economical progress since its union with the Italian kingdom, its several railways having now reached a length of over 500 miles, while its population, according to the last census, is about three millions.

A SIGNAL torpedo is being introduced on the Austrian railroads which presents some curious points. Instead of being placed in position, it is shot backward by a spring, being attached to a sort of carriage which enables it to slide along the rail, but does not allow it to fall off. By regulating the action of the spring the torpedo can be sent any required distance up to three hundred yards. All that the rear brakeman has to do is to place the torpedo slide on the rail, and give the spring the necessary impulse for putting it exactly where he wants it to stop. It is so arranged that he does not even have to leave the car in order to do it; the signals can thus be given while the train is still in motion. The whole apparatus weighs about half a pound; it rises less than ⅛in. above the level of the rail. Of course, a special form of torpedo is required for each particular style of rail. The inventor has also made arrangements by which a whistle may be attached to these torpedoes, in order that the watchmen, &c., along the line may be informed of the sending of these signals. It is operated by a rubber bag full of compressed air, which is fastened to the torpedo, and moves with it. We are disposed to think that the inventor has not gone far enough. The torpedo ought also to exhibit a red flag, and leave a long trail of grease behind it on both rails, so as to render the further advance of the coming train impossible. We should also recommend that it be fitted with an arc lamp for use at night, and a telephone, by which the driver of the advancing train could be put in communication with the standing train.

NOTES AND MEMORANDA.

THE usual explanation of the fact that liquid carbonic anhydride solidifies as it issues from the vessel in which it is contained, is that the solidification is caused by abstraction of heat by the quick evaporation of the liquid; the true reason being decrease of pressure below the melting point tension. The non-melting of benzene below the pressure of 35·6 mm. can be readily shown in the following way: A few c.c. of benzene are put into a short tube provided with a side tube, and the tube closed by a cork through which a thermometer is passed; the side tube is connected with a vacuum reservoir and a pump. The benzene is then solidified by means of ice, and the pressure in the tube reduced to below 35·6 mm. So long as the pressure does not rise above 35·6 mm. the benzene in the tube cannot be melted however much the tube is heated.

M. BERTILLON, in the course of a lecture delivered at the Hygienic Exhibition in Paris, stated that out of every 1000 inhabitants of Paris only 360 are natives of the city, 565 belonging to the departments of France or the colonies, and 75 being foreigners. There are in proportion, as well as in actual numbers, more foreigners in Paris than in most other large cities, the proportion being 75 in 1000, as against 14 in 1000 in Berlin and Trieste. The movement of the population for the past year throughout France was also very unsatisfactory, the total number of births being 922,361, or upon the average 30,000 fewer than for the last fifteen years. Upon the other hand, there has been a slight reduction in the number of deaths, the total for 1885 being 836,897; but even so it will be observed that the excess of births over deaths was only 85,464.

A REMARKABLE example of the increase of temperature in the earth toward the centre has been presented at Pesth, where the deepest artesian well in the world is that now being bored for the purpose of supplying the public baths and other establishments with hot water. A depth of 951 metres—3120ft.—has already been reached, and it furnishes 800 cubic metres—176,000 gallons—daily, at a temperature of 70 deg. C.—158 deg. Fah. The municipality have recently voted a large subvention, in order that the boring may be continued to a greater depth, not only to obtain a larger volume of water, but at a temperature of 80 deg. C.—176 deg. Fah. It is suggested that it is thus within the bounds of probability that the time may come when a brewer will obtain his water supply from a well of sufficient depth to yield "liquor" at the mashing temperature.

AT a recent meeting of the American Society of Mechanical Engineers, Mr. Wilfred Lewis read a paper on "Experiments on the Transmission of Power by Belting." Among his conclusions are the following:—That the coefficient of friction may vary under practical working conditions from 25 per cent. to 100 per cent.; that its value depends upon the nature and condition of the leather, the velocity of sliding, temperature, and pressure; that an excessive amount of slip has a tendency to become greater and greater, until the belt finally leaves the pulley; that a belt will seldom remain upon a pulley when the slip exceeds 20 per cent.; that excessive slipping dries out the leather, and leads towards the condition of a minimum adhesion; that raw hide has a greater adhesion than tanned leather, giving a coefficient of 100 per cent. at the moderate slip of 5ft. per minute; that a velocity of sliding equal to 0·01 of the belt speed is not excessive; that the coefficients in general use are rather below the average results obtained; that the sum of the tensions is not constant, but increases with the load to the maximum extent of about 33 per cent. with vertical belts and indefinitely with horizontal belts, and that as the economy of belt transmission depends principally upon journal friction and slip, it is important to make the belt speed as high as possible within the limits of 5000ft. or 6000ft. per minute; that quarter twist belts should be avoided.

A COMPARISON instituted by the *Scientific American* between the United States' Directories published in 1776 and those of the present year shows the wonderful growth of American newspapers. A century ago only 37 newspapers were published in the States, whereas the Directory for 1886 contains the names of 14,160 newspapers and periodicals of all classes. Out of this large list only 7 journals were found in the Directory of 1776. The net gain of last year was 666. The daily newspapers number 1216, a gain of 33. There are about 1200 periodicals of all kinds, which enjoy a circulation of more than 5000 copies each. The rural weekly press comprises about two-thirds of the whole list. Nearly every social movement and every industrial interest has its organ in the press. There are 700 religious and denominational newspapers, nearly one-third of which are published in New York, Philadelphia, Boston, and Chicago. Three newspapers are devoted to the silkworm, 6 to the honey bee, 32 to poultry, 18 to dentistry, and 9 to phonography. The prohibitionists have 129 papers, and the liquor dealers 8. The organs of women's suffrage are 7 in number, while 2 journals are devoted to gas and 3 to gastronomy. Of foreign newspapers there are about 600 in German and 42 in French. Two dailies are printed in Bohemian, and there are papers in the Swedish, Finnish, Polish, and Welsh languages. There are also publications in Gaelic, Hebrew, and Chinese, and one in the Cherokee language.

IN a paper on "The Action of Oils on Metals," Mr. I. J. Redwood gave a table which showed the weights of the different metals before and after exposure to the action of the oils. From it it appears that iron is least affected by seal oil, and most by tallow oil; brass is not affected by rape oil, least by seal oil, and most by olive oil; tin is not affected by rape oil, least by olive oil, and most by cotton-seed oil; lead is least affected by olive oil, and most by whale oil, but whale, lard, and sperm oils all act to very nearly the same extent on lead; zinc seems, by the four actual weighings that were of any value, to be not acted on by mineral lubricating oil, least by lard oil, and most by sperm oil; copper is not affected by mineral lubricating oil, least by sperm oil, and most by tallow oil. The table also showed that mineral lubricating oil has no action on zinc and copper, acts least on brass, and most on lead; olive oil acts least on tin and most on copper; rape oil has no action on brass and tin, acts least on iron and most on copper; tallow oil acts least on tin and most on copper; lard oil acts least on zinc and most on copper; cotton-seed oil acts least on lead and most on tin; sperm oil acts least on brass and most on zinc; whale oil has no action on tin, acts least on brass, and most on lead; seal oil acts least on brass and most on copper. From the foregoing results it will be seen that mineral lubricating oil has, on the whole, the least action on metals, and sperm the most.

THE method of treatment for congealing the rubber milk in the Para district, which equally applies to the milk of the *Hevea Braziliensis* and *Mangaleira*, is as follows:—Small cups are attached to the trees, and when filled with juice, are emptied into tin pails of a certain size, having close fitting lids, the cups being again attached to the trees. After going the round of the trees, the contents of this pail are emptied into another a size larger, and so on till the covered pail of largest size is filled and ready to be strapped on to the saddle of a mule for removal. By this plan the natives are saved the trouble of condensing and preparing the milk for market, by smoking. The large can of rubber milk on arriving at the *magasin* is emptied into a bath of water, the temperature best suited to the rubber being a matter of experience. The lumps of rubber that form in the bath are immediately pressed into thin flat sheets, and carefully wiped. By this means the acid is forced out of the cells or pores in the lump, thus preventing the so-called "rotten" appearance. The author is of opinion that the African rubbers yielded by the Landolphias, prepared in this manner, will produce a strong rubber. The African rubbers now sent here do not yield, when strained and cleaned, more than 30 per cent. to 55 per cent. of pure rubber gum, owing to the natives adulterating with sawdust, bark dust, &c., to overcome the inconveniences of the stickiness of the juice. The amount of resin in milks varies largely.

MISCELLANEA.

THE Governor of Victoria has turned the first sod of the irrigation works proposed to be carried out by the Tragowel Plains Irrigation Trust. The scheme is intended to serve an area of 80,000 acres, and is to cost £165,000.

MR. WHITE, assistant engineer to the Borough of Hull, has been appointed engineer to the borough, in place of Mr. J. Fox Sharp, resigned, by a vote of 28 against 24, and 2 for other two candidates, in the Town Council. The salary is £500 a year.

WE understand that the great rotary pumping engine, one of the largest in the world, used for draining the Friedensville zinc mines, Pennsylvania, has been started again, the mines being re-opened after being closed for seven years. The engine was fully illustrated in our columns in June, 1876. The engine lifts 15,000 gallons per minute 350ft. The cylinder is 110¼in. in diameter, and 10ft. stroke. The two fly-wheels weigh 75 tons each. There are four plunger pumps, 30in. diameter and 10ft. stroke, and four lifting pumps slightly larger.

THE *Calcutta Englishman* says that at the meeting of the Bombay Town Council on the 2nd ult., a resolution was passed accepting the tender of Messrs. Walsh, Lovett, Mitchell, and Co., of Bombay, for the construction of the Tansa Duct, including tunnels, conduits, formation of the pipe line, pipe laying, and bridges over the Bassein Creek, from the Tansa Dam to Ghatkopar, for the Bombay Waterworks. The contract for the iron pipes, some 45,000 tons, valued at 37,50,000 rupees, was placed with Messrs. Walsh, Lovett, as agents for Messrs. Macfarlane, Strang, and Co., in March last.

THERE has just been constructed at Mr. Skelton's yard, Millwall, a small galvanised steel steam yacht, for service on the river Bega, New South Wales. Her dimensions are—Length, 35ft.; beam, 8ft.; depth, 2ft. 9in.; draught of water with twenty-eight persons on board, 15in. The engines are twin-screw, with a single 4in. by 5in. cylinder to each shaft. Propellers, 15in. diameter. The machinery is by Messrs. Plenty and Son. The yacht has been constructed to the order of Mr. D. Gowing, a well-known colonial gentleman of Bega, New South Wales, and now on a visit to the Colonial Exhibition.

FOLLOWING the examples of London, Liverpool, and Edinburgh, the public men of Newcastle-on-Tyne have put forward a scheme for an international and colonial exhibition, to be held next year, in commemoration of the Queen's Jubilee. Plans prepared by Mr. W. Glover, a vice-president of the Northern Architectural Association, have been adopted, and the town council has just endorsed them. Eleven acres of land, adjoining the site of the Royal Agricultural Show, and within a mile of the central station, have been secured from the Corporation, and buildings will be put up over 226,500 superficial feet.

THE *Engineering and Mining Journal* speaks of the largest direct-acting pumping engine in the world, pumping against 1500 lb. per square inch pressure, and says one is constructing for the United Pipe Lines that has capacity to deliver 25,000 barrels of oil in twenty-four hours, against a pressure of 1500 lb. per square inch. It is believed to be the largest direct-acting pumping engine in the world. It has 41in. high-pressure steam cylinders with 82in. low, driving 12in. double-acting plungers, and is to be supplied with steam at a pressure of about 100 lb. per square inch. In this country, however, Messrs. Hathorn, Davey, and Co., of Leeds, have put up larger engines than this.

NEW mineral water reservoirs at Harrogate for the Corporation are being very rapidly proceeded with. It is estimated that over half a million bricks will be used in the construction of the separate tanks, 300 tons of cement, and 1000 loads of broken stone for the cement work. There are to be twelve tanks or chambers for receiving and storing the sulphur water, each of which will be 20ft. square and about 13ft. deep. Each chamber is capable of holding over 80 tons of water. Special precautions are being taken to render the constructive part of the work watertight by grouting with cement and otherwise concreting the structure. When completed and filled with water, the Corporation will possess double the present number of baths.

THE project for increasing the water supply of Leeds, which we described some weeks ago, is still perplexing the Town Council. At a recent meeting of the Waterworks Committee Mr. Filliter explained in detail his scheme—upon which Mr. Hawksley and Mr. Bateman had reported on the whole favourably—for constructing a tunnel at a distance of not less than 10 yards from the present tunnel, but on a higher level. Messrs. Hawksley and Bateman had, on the other hand, advised the construction of an additional tunnel 100 yards from the existing tunnel, and at a lower level; but as the committee required some further elucidation of that suggestion, a deputation is to come up to London to confer with the two eminent engineers referred to.

AN official report which has been issued shows that the production of manganese in Russia is steadily increasing. The exports for the first four months of this year amounted to 9000 tons, as against 4500 tons for the corresponding period of 1885. This is shipped principally from Poti, where it is conveyed by the Transcaucasian Railway from the mines, in order not to interfere with the petroleum trade of the neighbouring port of Batoum. Owing to the frightfully bad condition of the conveyances used in transporting it from the mines at Tchiatoor to the Transcaucasian Railway, large lumps of ore only can be carried, the result being that the smaller pieces, which are equal to two-thirds of the total quantity extracted, are wasted, although equal in quality to that exported. This shows that if the Government carry out the projected line from the mines to the railway, the price of manganese ore in this and other countries will decrease very considerably.

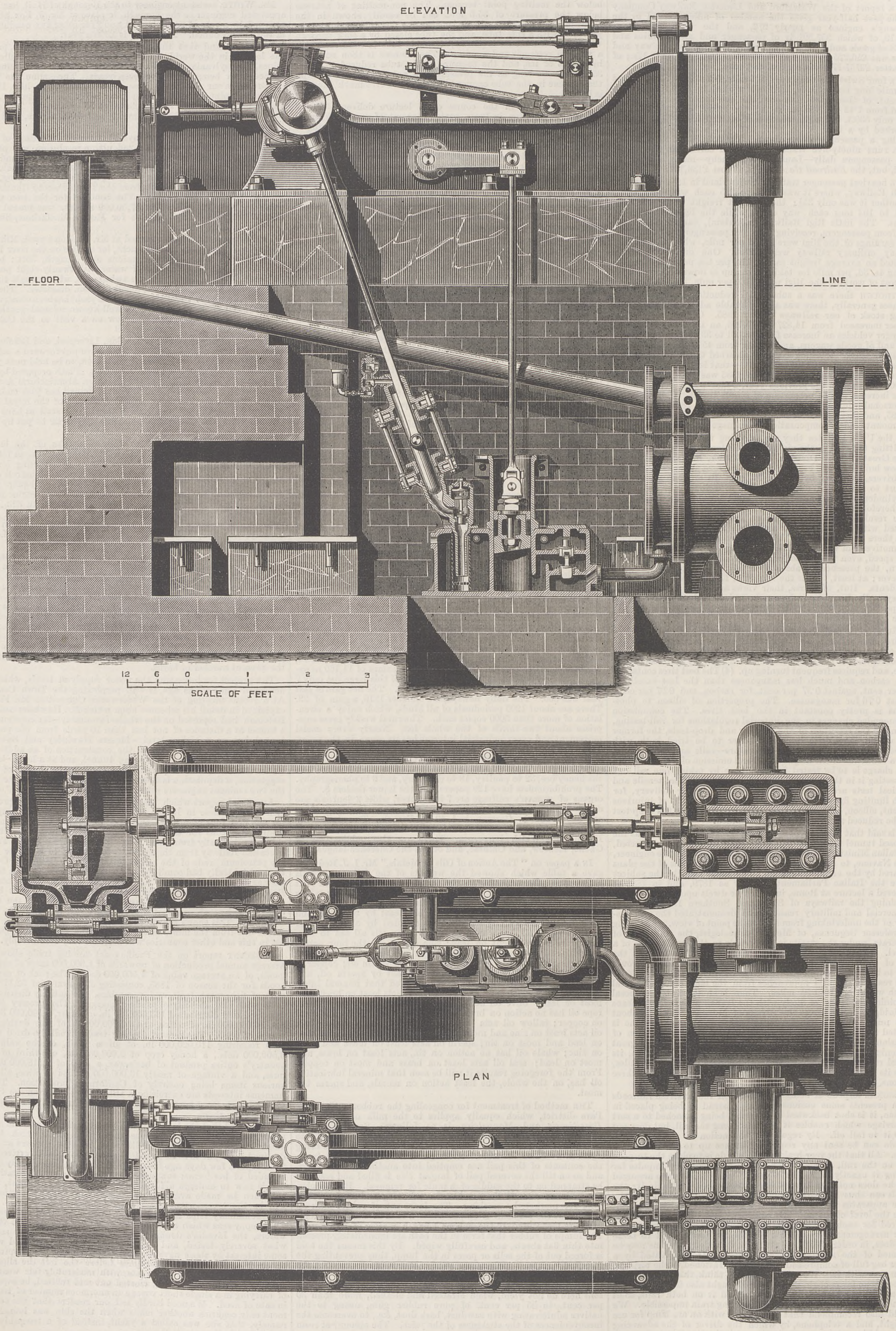
A RECENT report on the Pacific coast canning trade shows an average annual production of upwards of 1,500,000 cases of canned goods, of an average value of 4,500,000 dols. The pack of canned goods for the season of 1885, consisting of upwards of 52,113,320 cans of fish, meat, fruit, and vegetables, was entirely distributed to a wide and steadily expanding market. The grocery trade imported and distributed 163,500,000 lb. of sugar, 6,500,000 lb. of tea, 16,000,000 lb. of coffee, and 50,000,000 lb. of rice during the season of 1885. The general jobbing trade handled a dried fruit crop requiring 110,000,000 lb. of green fruit, of the value of 3,500,000 dols., a honey crop of 2,000,000 lb., one-third of the country's entire product of bee's-wax, a crop of 2,818,000 lb. of nuts, and a vintage of nearly 10,000,000 gallons of wine, all the various items being entirely of Californian production. These immense interests are exercising a stimulating effect on the trade of the Pacific coast generally, and some tin-plate makers must be kept busy by them.

IT is stated that the late Imperial yacht Livadia, upon the magnificent equipment and gorgeous embellishment of which Alexander II. lavished so many millions of roubles, appears at last destined to be put to some practical use. The Livadia arrived at Sebastopol a few days ago from Nicolaieff. She has already been denuded of her former sumptuous appointments and decorations, but is now to undergo a further and radical cleaning out, and will then be made available as a troopship. Her chief mission will be the transport of troops from Sebastopol to Batoum. If her preliminary trips happen to be made in some of the heavy and choppy seas which are not unfrequently experienced in these waters, the Livadia's doubtful sea-going capacity will be somewhat severely tested, and her behaviour will be watched with some interest by those naval experts and designers who approved or condemned her structural lines before she left the slips of Elder and Pearce. At all events, with moderately fair weather the Livadia will, after being cleared out and refitted, be capable of carrying in a single short voyage an enormous number of troops in case of need. We need hardly tell our readers that the statement only confirms another made when the ship was launched, namely, that she was called a yacht, instead of a troopship, to throw dust in the eyes of Europe.

COMPOUND PUMPING ENGINES, STOCKTON-ON-TEES WATERWORKS.

MESSRS. WORTH, MACKENZIE AND CO., STOCKTON-ON-TEES, ENGINEERS.

(For description see page 194.)



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

CONTENTS.

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G. B.—*Hansards, Great Queen-street.* 4½*d.*

W.—*We have no reason to think that there is any limit to the application of Rankine's rule.*

PERPLEXED MECHANIC.—*Make your air pump to suit the small cylinder of your compound engine.*

J. H. (Forest-gate).—*You can consult the back volumes of* THE ENGINEER *at the Free Library, Patent-office, Southampton-buildings.*

G. S. (Milan).—*The average cost of an American patent, including drawings, agent's fees, &c., is about £28. The official fees are 35 dols.*

CONSTANT READER.—*Your wheel has too many floats; forty-five would be a better number. You say nothing about the ventilation. The speed of the wheel should not exceed 6ft. per second as a maximum; five and a-half to six revolutions will no doubt give a better result.*

STEEL.—*If you can get a bit off the boiler in any place you can tell whether it is steel or iron. It is by no means easy to say what an old boiler is made of by merely drilling a hole in it. An experienced boiler-maker would, however, probably be right in the opinion he would give on the subject nine times out of ten.*

A. H. C. (Woodside, Aberdeen).—*Apply at the principal post-office in your town for a set of forms. These are very easily filled up if you comply with the marginal instructions. The provisional specification is a short, general description of your invention. It must be prepared in duplicate. If there is not room on the printed forms, you can finish it on foolscap ruled paper, leaving a margin of two inches at the left-hand side. The stamp costs £1. Send the papers, when filled up, to the Great Seal Patent-office, Chancery-lane. As you have had no experience, we cannot advise you to attempt to take out a complete patent for yourself, as you are sure to make mistakes. An error in a provisional is of small moment compared to one in a complete specification.*

WOLFRAM STEEL.

(*To the Editor of The Engineer.*)

SIR,—Will any of your readers oblige by informing me where the wolfram steel, mentioned in your yesterday's paper, is to be got in England?

J. K. S.

Colchester, August 28th.

DECAY IN BOILER TUBES.

(*To the Editor of The Engineer.*)

SIR,—I would feel obliged if any of your readers would give me some information as to the cause of the decay in the tubes of my boiler. The engine is working now scarce six years, and already I have had to replace the tubes three times. The only fuel available in the neighbourhood is peat, and the water I use is collected in a concrete tank from the corrugated iron roofs of the farm buildings, which are situated within a few hundred yards of the sea. The tubes do not rust all over, but become perforated at some one certain spot, the rest of the tube being perfectly good and strong. Can there be any salts in the water thus caught, caused by the action of the salt air on the corrugated iron roofs, which would thus affect the tubes, and if so, what is my remedy? The only other water near hand is so heavily charged with iron that I fear to use it.

August 31st.

RUST.

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THE ENGINEER.

SEPTEMBER 3, 1886.

MIXED TRAINS.

A MIXED train is one made up of passenger coaches and goods wagons. In England there are comparatively few mixed trains run, but in poorer countries they are very common. Thus on most of the Irish railways a certain proportion of the traffic is carried on by mixed trains. There are two methods of making up such trains adopted. According to one, the passenger coaches are placed next the engine, with the goods wagons behind; according to the other plan this arrangement is reversed. The principal object had in view is to secure the maximum amount of safety for passengers. Some years ago, and for many years, the officers of the Railway Department of the Board of Trade were at variance as to which was the best method; and when official reports on accidents to mixed trains appeared, the arrangement of the trains was censured or praised according to the individual opinions of the officer reporting. The late Colonel Yolland, if we are not mistaken, held that the goods wagons should be put next the engine; while General Hutchinson maintained that that was the proper place for the passenger coaches. Within the last few days the Board of Trade have issued a circular letter strongly advising the railway companies always to put the passenger coaches first. We hold that this is dangerous advice, and that no evidence can be adduced to prove that it is not.

The immediate origin of the circular letter is an accident which took place on the 26th of May on a branch of the Great Southern and Western Railway of Ireland; and so far from supporting the circular, it indicates that the proper position for passenger coaches is at the end of the train furthest from the engine. With the facts before them our readers will, we think, have no difficulty in admitting this. On the 26th of May, at 4.28 p.m. a mixed goods and passenger train started from Birdhill for Nenagh, consisting of a Great Southern and Western Company's engine and tender, two Waterford and Limerick Company's covered wagons, a Great Southern and Western Company's covered wagon, a Waterford and Limerick Company's open wagon, two brake vans, a third-class carriage, and a composite carriage, eight vehicles in all, coupled in the order given. This train was proceeding on its journey at a spot about 7¼ miles from Birdhill station, when the wagon next the engine left the rails, and after this wagon had lost its own wheels, thereby causing the wheels of the three following wagons to be swept from under them, the train was stopped about 312 yards from the first well-defined mark of a wheel having left the rails; when the four wagons were off the rails, and the first van had its front wheels mounted on five pairs of wagon wheels which were piled up in front of it. The wheels of the engine and tender, the trailing wheels of the first van, and all the wheels of the three rear vehicles, were on the rails. No personal injuries were sustained. The damage to the rolling stock consisted in the three front wagons being more or less broken up and the wheels stripped from under the fourth wagon; the first van was a good deal damaged, and also the buffers and springs of the other three vehicles.

The speed of the train was not excessive, possibly a little over thirty miles an hour. The line was curved to about a mile radius, and according to the evidence the permanent way was in good order. The driver felt what he describes as a "chuck," and instinctively shut off steam, applied the vacuum brake to his engine, and whistled for the guard's brake at the end of the train. All this took place in a very few seconds. He then looked back, and saw the wagon next his engine off the road and "making for the drain" at the outside of the curve. Therefore, he took off his brake, and gave the engine a little steam to prevent the train piling up. The wagon then crossed the road to the inside of the curve. The fireman put on the hand brake, upon which the end of the wagon dropped down, when he took the brake off and the train gradually stopped about 312 yards from the place where it mounted the rail. The guard, riding in a van about the middle of the train, put on his hand brake as hard as he could, and looking out of the door he stooped to avoid a piece of flying iron, and fell out on the road, but was unhurt. To us it appears that the driver acted with excellent judgment and presence of mind. It is very easy to be wise after the event, and to say that he ought not to have shut off steam until he had found out what had occurred. But he did what ninety-nine men out of a hundred would do, and then, as we have said, he handled his train very prudently and successfully until it stopped. As to the immediate cause of the accident, that appears to have been due to the fracture of a sole bar and the dropping out of a spring, the wagon which left the rails being, according to the evidence of a wagon examiner, unfit for use, the sole plate being cracked—in fact it ought to have been condemned and broken up two or three years before.

General Hutchinson's view of the whole matter is curious. He condemns the action of the driver without hesitation. On this point our readers will draw their own conclusion. It is with the concluding passage of his report, however, that we are now concerned. This is what he says: "The occurrence of this accident again draws attention to the grave dangers incurred by passengers travelling in mixed trains, when wagons of ordinary construction are placed between the engine and passenger carriages, upon which practice the Board of Trade have so frequently had reason to animadvert. In the present case the damage was happily confined to the four wagons and to the brake-van next following them, but the results might have been far more serious, and it is satisfactory to learn that the Great Southern and Western Railway Company has taken warning by the accident, and has issued an order, dated June 1st, 1886, requiring the wagons in mixed trains to be run in rear of the passenger carriages, with a van in rear of the whole. I trust that means will be taken to see that this order is strictly complied with, and that the Waterford and Limerick Company and other companies running mixed trains with wagons of ordinary construction next the engine will likewise take warning, and not wait for further accidents before issuing a similar order and taking means to have it enforced."

Now, that this accident draws attention to the fact that passengers incur a certain amount of risk when travelling by mixed trains, we do not for a moment dispute. But that it proves that less risk would be run if the passenger carriages were next the engine we entirely deny. As a matter of fact, no one was hurt, nor were the passenger coaches injured; so that General Hutchinson could not have selected a worse example to enforce his views, or to furnish a text for the circular letter to which we have referred above. In dealing with this question we have to keep probability before our eyes, because there is nothing certain about a railway accident in the sense that what will take place can be accurately foretold. It is clear enough, however, that either a carriage or a wagon can get off the rails. In the train to which the accident under consideration occurred there were but two passenger coaches, weighing probably about 10 tons each. If the wagons were fully loaded, they would probably weigh a little more; but let us take them at 10 tons. There were four of them, and two brake vans, weighing as much. In all, say, 60 tons of goods and 20 tons of passenger vehicles. Now if one of the passenger carriages had left the rails, the train being made up as General Hutchinson proposes, it would have been caught between the engine and the wagons, and could hardly escape being smashed up. In this very case, the wagons, which were presumably stronger than the carriages, were all smashed up; and if people had been in these wagons they would, beyond doubt, have been killed or maimed. Let us suppose further, that the carriages had been next the engine, and that the immediately following wagon had left the rails. It is by no means impossible that it would have pulled the carriage off with it, and in any case it is not impossible that it would have smashed in the trailing end of it. Few people would care, we fancy, to be in a coach just in front of a wagon being smashed up by others heaped upon it. It has been our own fate on many occasions to travel in a passenger coach next an engine with as many as fifteen covered goods wagons behind us, and to watch these wagons as the train came down an incline swaying and jumping and plunging was not quite the most pleasant sensation in the world. If General Hutchinson's views are adopted then the passenger coaches will be interposed as a buffer between the engine and train, and should the engine leave the rails there would not be the smallest chance of their escape.

What are the special dangers to which passenger coaches are exposed at the rear of a train? On this point General Hutchinson is quite silent. He does not give the least hint of what is passing in his mind. Of course, if something runs into the tail of the train, it would be bad for the passengers; but, on the other hand, would they be worse off than if when next to the engine that engine pitched into another train? We think there can be no two opinions about this. The only possible special accident that can occur to the carriages at the rear of a train is that a goods wagon leaving the rails, or breaking down in front of them, they may mount on the wreck or be derailed. But they would be infinitely better off in this case than they would be with a whole goods train behind them ready to climb on them. It is very difficult to combat the opinions of a man if he gives no reason for holding those opinions, and we wish therefore that General Hutchinson had favoured the world with his reasons for arriving at the conclusions we have quoted. Traffic managers will, as a matter of course, follow the Orders of the Board of Trade. Some day there will be a bad smash, and the companies can then plead that they have done what the Board of Trade ordered, and so wash their hands of all responsibility. We repeat, that the proper place for passenger coaches is at the end, not the beginning of a goods train, and we shall continue to hold that opinion until some sound argument which we have overlooked has been advanced to prove that we are wrong. The Board of Trade is, we think, ill advised in this matter to issue a peremptory circular on a most flimsy basis. In any case it would have involved a very small additional outlay to append to the circular a statement of a few cases which served to show that additional risk is incurred when passenger carriages are placed at the tail of a goods train, and additional safety secured when they are marshalled next the engine. We cannot help thinking that they were not appended because they do not exist.

RIVER FLOODS IN IRELAND.

ONE of the numerous causes of poverty in Ireland is the imperfect development of what we may designate her direct sources of food supply. Almost destitute of mineral wealth as compared with this country, agriculture is perforce her chief industry, and to this fact is possibly in a great measure due the "land hunger" prevailing there. Yet the most is not made of the land. A large area of it is naturally sterile, and would never repay reclamation; but another area is extremely fertile, and if certain engineering works were carried out its fertility could be turned to useful account. We refer to those tracts of land periodically submerged by floods in the Shannon, the Barrow, the Nore, and other large rivers. As it is, certain reclamation works have been, it is true, carried out, but much remains to be effected. Many thousands of acres of grass land in the valleys of the large rivers represent at present regions of merely speculative value. A man holding land of this kind never knows from day to day whether it will give food to his cattle the succeeding day or not. What is good grazing land now may have one or more inches of water mixed with suspended alluvium over it before the next sunrise, and whether the water remain for a day or for a week the damage done is nearly equal. The suspended alluvial matter is deposited upon the grass and renders it valueless till rain comes to wash it off, and as the rain, if at all in excess, is sure to cause another flood, the life of the farmer in such districts is not happy.

An Irish Commission held an inquiry concerning the floods of the river Barrow, of which the results may be summarised as follows, and will serve to illustrate what we have just written. The Barrow and its tributaries drain an area of watershed of 408,000 acres, all this water is concentrated in a single channel at Athy. Floods in this river frequently cover 22,000 acres to a depth of a foot, while 23,000 acres are saturated to the surface. This flooding is productive of more evils than one. We have already shown that the grass is injured and rendered almost valueless; but other evils are also caused, for example, the solar heat that should go to warm the soil and promote vegetation is absorbed in the work of evaporating the water, and this process also is productive of fogs and unhealthy miasmas. Another important fact is too often lost sight of in relation to this subject, namely, that river-flooding is a progressive evil. Left to itself, it in most cases slowly but surely increases, owing to the deposit of the alluvium washed down by the head-waters, and settling in and filling up the bed of the river down stream; and the reduction of the depth of the lower channel, even by a few inches, often entails a wide extension of the areas flooded. This is a subject which has already been fully dealt with in our pages. Mr. Fitzgerald valued all the district flooded by the Barrow for the Irish Board of Works. He estimated that draining the land to a depth of 4ft. for an area of 45,640 acres, the increased value would be £10,018 per annum. Mr. Manning, the chief engineer to the Irish Board of Works, proposed to widen and deepen the river from Athy to the outfall a considerable distance, a bottom width of 160ft., with side slopes, and at such a level as to produce a maximum depth of 9ft. 6in. of water, while its surface would be low enough to afford an outlet for the drainage of the land into the river at all points. It must be, however, observed here that a double problem of engineering work is thus involved; because, not only was Mr. Manning considering river flooding pure and simple, but also bog drainage as well; and hence, not only was the Barrow to be prevented doing actual injury by flooding, but Mr. Manning also sought to make the channel of the river an active instrument of drainage. The dimensions of the river would, of course, be diminished as it extended up stream. For sixteen miles from Athy to Monasterevin the incline was to be 15in. to the mile. The discharging capacity of the river at Athy would be 400,000 cubic feet per minute, with a maximum mean velocity of 4ft. per second. Evidence given by Mr. Manning went to show good reason to believe that this discharge would not be exceeded, or only under very exceptional circumstances. For the upper parts or head water of the district as well as for smaller and steeper areas, Mr. Manning estimated the flood discharges at three cubic feet per minute per acre. The estimate for the requisite works on this basis, including contingent expenses for sluices, &c., was £474,664; therefore, as the area injured is 45,641 acres, the average cost would be £10 11s. 3d. per acre. How this money, or, indeed, as a rule, the money for any similar work, is to be obtained is not merely an important, but it is the crucial point. No sane person will dispute the abstract truth that it is expedient, especially in a poor country, to gain as much of its fertile soil as possible for food production, always admitting that it must be done profitably, or so effected that one man will not be unduly taxed for the benefit of another man.

Mr. James Stewart Kincaid gave evidence on behalf of a landowner in Kildare, within the area to be dealt with, being himself also a trustee of some drainage boards, and he gave it as his opinion, based on experience gained on many estates situated in different parts of Ireland, that the contribution to the drainage works should not be confined to the lower lands more immediately and extensively benefiting by the proposed works when carried out, but should embrace the entire watershed area of each portion of the river as regards the maintenance of the main waterway, arguing that every one in the catchment basin has a right of free waterway to the sea, but each has also a duty in helping to maintain that waterway in good order. He also said, however, that the rate for the head waters ought to be a small one. Another reason for putting a charge on upstream districts is that the silt filling up the river bed lower down is brought from the upper districts. Mr. James Fennel, another witness examined, supported these views. The same point has been raised with regard to English rivers, and very keenly contested; so keenly, indeed, that the difference of opinion has done something to retard the work of regulating rivers in England.

This case of the Barrow differs in some respect from, let us say, such a river as the Nore, which is about the same size. Each year large areas of land otherwise of great fertility are flooded and greatly depreciated in value by this river. Much of it is virgin alluvial soil formed by gradual deposit, and needing no bottom drainage. It is land which, if flooding were prevented, would form dairy or grazing land of great value. The flooding of the areas situate, say, between Kilkenny city and Ballyraggett, about eleven statute miles distant by road or river course, is due to various causes, all of which must be taken into account whenever the prevention of the floods there comes to be considered. Some of the causes, for example, are certain mill weirs in Kilkenny city, which dam the river back and raise its surface level; other weirs at two points higher up stream also operate. Besides these, a tributary called the Dinan, in summer a small shallow stream, becomes in rainy seasons a torrent, and it enters the Nore at a right angle, forming in itself a dam to the main stream, which is very sluggish. This tributary has also, as might be supposed, formed a bar of sand and gravel obliquely across the main channel, and this aids in the mischief, because at all times it is operating to diminish the speed of the Nore water, thereby promoting the deposit of detritus and alluvium in the bed; thus in various ways the permanent level of the surface water is raised. We cite this simply as a typical example of a combination of conditions tending to cause floods. Difficulties exist that must be taken account of in any improvement scheme here not touched upon at all in the case of the Barrow above referred to, but they are such as exist about many other river improvement schemes. For example, the millers must be compensated if their weirs are to be removed, or their water rights interfered with, and next to them come the interests of the landowners down stream, upon whom the removal of bars and the lowering of weirs would bring down a vast quantity of water, now at present held in check from them by the obstacles it might be proposed to take away. Mr. Manning's and Mr. Kincaid's scheme to raise the necessary funds off the districts contained in the watershed drained, say, by the Barrow, might be possible in some cases; but in many we suspect it would not, and we are of opinion that in cases where no interest save an agricultural one is concerned, any comprehensive and effectual scheme for the prevention of river floods must be carried out with money lent by Government, spent under Government supervision, and to be repaid by instalments extending over a long period. Not only, however, must money be spent if the works are to be carried out, but an annual outlay will have to be provided for, to maintain the works in good order, and there is too much reason to fear that the land gained would not repay the requisite outlay. From an engineering point of view such schemes are interesting, but their commercial success is extremely doubtful. In certain cases, however, a moderate outlay would no doubt bring in a large return; and it is to be regretted that Commissioners who inquire into drainage questions have not devoted more attention to such cases, singling them out, and distinguishing them from others of such gigantic proportions as that propounded by Mr. Manning.

SHIPS, INDIA-RUBBER, AND GUNS.

THE experiment which took place with the Resistance at Portsmouth on Thursday, August 26th, is important, and deserves notice. The necessity for thickening armour in order to meet the rapidly increasing power of ordnance led to the consideration as to what parts of the ship might be left without armour without actual danger to her existence or efficiency as a fighting machine. Hence certain portions, such as the water-line amidships, the magazines, engines, sufficient hull to secure the vessel remaining afloat, and principal guns have been included in the category of so-called vital parts, and have been protected by vertical or horizontal armour, while other portions have been allowed to take their chance with thin armour, or nothing more than the thin steel or iron side of the ship. This system of construction led to the development of quick fire attack, carried on by guns loaded by hand, but supplied with fixed ammunition—that is, ammunition in which charge, projectile, and cap were contained in a single metal case, as in small arm cartridges. By this means, coupled with arrangements for bringing the gun back into position after recoil, 6-pounder and 3-pounder guns can be fired very rapidly. In fact, a rate of seventeen rounds a minute without aiming, or twelve rounds taking aim, can be maintained for some time; consequently, unarmoured, or slightly armoured parts of a ship may be cut away at a rate which endangers her safety. For while a few rounds even from large guns might not cause intolerable inconvenience, the destruction of the sides by quick fire which might be applied to nibble the structure rapidly away just at the most important parts might, it is thought, quickly endanger the ship or reduce her to impotency by hampering her movements. Large holes, well forward and near the water line, for example, would cause water to enter freely when the ship moved quickly. This, at all events, has been strongly urged. Captain Fitzgerald, in a paper read at the United Service Institution on January 21st, 1885, argued that the Hercules by this means could disable the much more formidably armed and more modern Italia before the latter could fire her four 100-ton guns more than once. Captain Fitzgerald, we believe, has subsequently advocated strongly the employment of india-rubber for unprotected parts of ships. Preliminary experiments appeared to show that a thick sheet of india-rubber would close up after a machine gun or even a quick fire gun bullet had passed through it so as to prevent the entrance of water. Asbestos and cork have been similarly used under the appellation of contrivances. This is the question which was tried at Portsmouth on the 26th. The Resistance was anchored in St. Helen's Roads, in $5\frac{1}{2}$ fathoms of water, with 300 tons of ballast to give her a list to starboard. The india-rubber sheets, of various thicknesses, were fixed inside the vessel, divided into compartments numbered from 1 to 4, on the port side, which was heeled up out of the water. The Pincher fired two rounds of steel shells from 6-pounder quick-firing gun, which passed through No. 4 compartment, "tearing into shreds the india-rubber," which was placed at $3\frac{1}{2}$ft. from the ship's plates, and passing through two bulkheads, splintering the wood in all directions. The Blazer then fired with 5in. breech-loading common shell weighing 50 lb. In No. 3 compartment, where the india-rubber was only $\frac{1}{2}$in. thick, it was torn away, the shell smashing the bulkheads in the rear, but not passing through the ship. A clean hole was made in the ship's plate. Two more similar shells were fired through 1in. india-rubber, and two through $1\frac{1}{2}$in.; 6in. gun shells were afterwards fired through $1\frac{1}{2}$in. india-rubber. On righting the ship, water entered the holes so fast that they had to be plugged to prevent the vessel from sinking. The Pincher then fired her 6-pounder quick-firing gun against a part of the Resistance's hull which was covered outside with india-rubber, and another part lined with asbestos 14in. thick, supported by a thin steel plate. Seen from outside, it appeared as if little damage had been done; but the shots had passed in through the india-rubber, carrying *débris* with them, and water poured in freely. The asbestos closed up behind the shot.

The most important part of the trial is the action of the 6-pounder quick-firing gun shell, for the reason given above—that it is by quick fire that destruction to unarmoured parts of ships is threatened. The larger shells could hardly fail to cause leakage, but they can only be delivered comparatively slowly. It was hoped that the remarkable action of closing in of the india-rubber might have been effectual in keeping out water; but it is not surprising that this should not be the case under any great pressure of water. The results are thought sufficiently discouraging to prevent further trial at present.

RESTRICTED OUTPUT IN CLEVELAND.

THERE seems to be now no longer any doubt but that the Cleveland ironmasters mean to carry out their policy of restriction forthwith. A definite agreement has been drawn up and signed, and in case of any dispute arising hereafter as to the interpretation of any of the clauses thereof, it is to be submitted to the final decision of a chartered accountant of recognised position, who has been already appointed. The present arrangement differs in some respects from anything previous. The most important new provision is that none of the contracting parties will be bound to blow out any furnace or any number of furnaces. All will be left to use their judgment as to whether they blow out or damp down, or put on slack blast, provided only that the total previous output is diminished by 20 per cent. In this way every ironmaster will be secured against the danger of any competitor evading the agreement by blowing remaining furnaces harder than before, and thereby getting a larger quantity per furnace. For want of an agreement drawn up in this way, past restrictive arrangements have always failed to secure the object for which they were made. The new restrictive experiment will be tried for a period of eighteen months at least, and will be put in force on and from the 1st of September. It is understood that Messrs. Bolckow, Vaughan, and Co., intend to blow out three furnaces; Bell Brothers, two; the Cargo Fleet Iron Company, one; Downey and Co., one; and Jones, Dunning and Co., one. At Edward Williams' and Stephenson Jaques and Co.'s works, one furnace will in each case be changed from Cleveland to hematite iron. Messrs. Wilsons, Pease, and Co., B. Samuelson and Co., and Gjers, Mills, and Co., will either blow out a furnace each, or by slack blast reduce their output to the required extent. Meanwhile the blast furnacemen and ironstone miners have been getting very uneasy at the prospect of reduced work, which they see looming ahead of them. The usual and natural way to meet the lessened demand for labour would be to discharge a certain proportion of the operatives, retaining the remainder in full work. The men, however, do not like this idea. They would prefer that the same number of men be kept at work, but that a shorter number of hours should be worked per man per week. They have made an appeal in this sense to the Ironmasters' and Mineowners' Association, but no definite answers have as yet been given to them. It is scarcely likely that they will receive a reply favourable to their wishes, for the employers must do their utmost to lower cost of production. One great element of cost consists, of course, in the wages of the operatives. These have not yet fallen in proportion to the fall in value of the necessaries of life. Consequently all workmen in full employment are better off than ever, and those only who have partial employment or none at all are really feeling the pinch. By discharging some of their workmen and keeping the remainder in full employment producers have a good chance of forcing down wages to the requisite lower level, for fully employed operatives can well afford to submit to further reductions, and they are none the less accommodating when they are conscious that there are so many idle men eager to fill vacant places. On the other hand, if all the workmen in the district were partially employed, as they desire, all would be equally pinched, reduced wages rates would become impossible, for there would be no absolutely idle operatives to compete. Consequently, from a producer's point of view, it would be an exceedingly unwise and suicidal policy to agree to the men's proposals.

THE COST OF STEAMSHIP INSURANCE.

SOME remarkable facts as to the cost of the insurance of steamships have been recently published, which are well worth general consideration. One of the most interesting is a statement of the actual sums paid by the owners of twenty vessels insured in what are called mutual clubs. Each of the vessels was worth on the average £20,000 at the time of the commencement of insurance—that is, when they were new; but they have deteriorated in value. The first vessel has been insured for seven years, and there has been paid £17,576, and so on downwards through the whole of the list, until for the latest built of the vessels—one which commenced her risk in the past year—£665 have been paid. In all, there has been paid for insurance for the twenty steamers not less than £148,634. By the mutual club system of insurance, calls necessarily come after the risk has ceased, and these back calls are estimated at £10,000. Some of the steamers have been damaged in various ways, and have been thus entitled to receive amounts from the insurance clubs. In all, in the seven years they have so received £40,477; but they have paid in the period a net sum of £108,157 more than they have received; and it is estimated that a further sum of £10,000 is payable for the cause named. In other words, the twenty steamers have paid under the mutual system more than £5500 each above what they have received. This is not the total cost of insurance, for there are portions of the cost of loss or damage which fall on the steamer concerned, no matter how fully she may be insured; so that the cost is more than that stated, though how much more cannot be exactly defined. If we take the average of the time they have been insured, it works out about three years; so that over £1800 per year has been paid for insurance in clubs in addition to that paid privately. On the basis therefore of these figures of actual experience, the cost is most remarkable, and is extremely heavy. It is not only the cause of the non-remunerative character of our shipping just now—for it will be seen that if the steamers are now paying their way the reduction of the insurance would give a speedy and substantial dividend to the owners of the vessels—but it is also a heavy drain on our national resources. This enormous sum of money paid by one fleet of vessels in so limited a time—a sum of over £118,000—is startling on the face of it. It calls for some changes, for it must be remembered that the payment, the modes of assessment, and the whole management of the clubs are wholly in the hands of the managers of the vessels who form the club committees. A very large part of the amount is paid for the repairs of the vessels; and if the commercial practice of taking tenders for these repairs were followed, it is the belief of many that the sums paid for this part of the total would be speedily decreased, and that to a considerable extent. But the method of the reduction may be well left; what is needed is that these should be impressed on the public—and especially on that part of it which is interested in steamships—the absolute need for greater economy in steamship insurance, for it must be apparent that without this, under present circumstances, as to the earning power of vessels, there is scarcely a probability of the mercantile fleet becoming more remunerative to its owners, whatever it may be to its managers.

AN OLD GERMAN PUMPING ENGINE.

The August number of the "Proceedings of the Union of German Engineers" contains an interesting account of the first steam engine built in Germany, and probably the first machine of the kind ever seen in that country. It was erected from the designs of Bergassessor Bückling, who had been deputed to visit England for the purpose of studying the best examples to be found, and it was first set to work at the König Friedrich Mine, near Hettsteat, Thuringia, on August 23rd, 1785. It was single-acting, the cylinder having a diameter of 28in., and the valves worked by a plug frame suspended from a huge beam provided with arch heads in the manner usual at that period. It was, in fact, a very close copy of the then prevailing Watt type of engine. The machine does not seem to have been a success, for the boiler gave way and the engine came to a standstill. On investigating matters, a "mountain 20in. high" was discovered inside the boiler, the feed-water being of a highly calcareous nature. A new boiler was accordingly provided, but still this engine could not keep the water down. Bückling was again despatched to England, and a larger cylinder of 34in. diameter was ordered at Homfray's foundry at Penydarran, the scene of Trevithick's early experiments. But what was of more importance than a new cylinder, Bückling succeeded in obtaining the services of an experienced engineer named Richard, whose engagement was a matter of the greatest difficulty, the laws against the enticing of skilled artisans abroad being then in full force. With Richard's help the engine was reconstructed, and remained at work until 1794, when it was taken down, to be removed, in 1797, to the Hoffnung Mine, at Löbejün, where it did duty until 1848. Richard seems to have remained permanently in the Prussian service and to have erected other engines at various mines. A large folding plate is appended to the paper in the *Zeitschrift*, giving a general view of the engine from a drawing made by Carl Eckardt in 1797—that is, subsequent to its removal—together with a number of details to scale. These latter sketches were taken by Friedrich Fricke in 1794, no doubt when the engine was taken down. We hand these names down to posterity in gratitude to the draughtsmen for having preserved with so much exactness the particulars of almost every part of a pumping engine of the last century. Writers on the history of the steam engine and collectors should note this article, and for their special benefit we give the exact reference, viz., *Zeitschrift des Vereines deutscher Ingenieure*, vol. xxx., pp. 721-3, plate 24 (Berlin: Julius Springer).

ANOTHER INTERNATIONAL EXHIBITION.

In addition to the Exhibitions being arranged for Manchester and Newcastle next year, there is now, it appears, to be one at Saltaire, the prosperous model industrial town in Yorkshire founded by the late Sir Titus Salt, from whom it takes its name. This International Exhibition was to have been opened during the present summer, but unavoidable delays have arisen, and now it will be held in the Jubilee year. The scope of the project is this:—Sec. I. Fine arts. Sec. II. Scientific appliances. Sec. III. Educational appliances. Sec. IV. Clocks, watches, and other timekeepers; jewellery, electro-plating, &c. Sec. V. Music. Sec. VI. Hygiene, food. Sec. VII. Furniture and decoration. Sec VIII. Pottery, glass, and kindred industries. Sec. IX. Chemistry and pharmacy. Sec. X. Animal and vegetable substances, and their manufacture. Sec. XI. Paper manufacture, stationery, printing, bookbinding. Sec. XII. Machinery—prime movers. Sec. XIII. Manufactures in metal. Sec. XIV. Railway, tramway and vehicular appliances. Sec. XV. Civil and military engineering, building construction and shipbuilding. Sec. XVI. Minerals, quarrying, and metallurgy. Sec. XVII. Agriculture, horticulture, &c. Sec. XVII. Women's industries. From these facts it would appear that this is to be one of the most comprehensive and varied Exhibitions ever held. It is being organised by the governors of the Salt Schools, and the primary objects of the scheme are to afford the population of the West Riding and of the North of England an opportunity of studying examples of the best work yet achieved in the several departments of art, science, and general industry, and to assist in defraying the cost—£10,000—of a new science and art school to be erected as a memorial of the late baronet. Already promises of loans have been received from the Prince of Wales, the British Museum, the Trinity House Corporation, South Kensington Museum, the Royal Mint, the President and Council of the Royal Academy, the Marquis of Ripon, Sir F. Leighton, P.R.A., in his individual capacity, Sir J. E. Millais, Sir James Linton, several of the Indian and Colonial representatives, and many other bodies and persons.

NOVEL BELLS.

There is always risk of failure in casting large bells; uncertainty whether the bell will be sound when cast; and liability to eventual fracture. The carriage of such heavy weights as bells of large dimensions to their destination, and the hanging of them when there, are always matters for serious consideration. It will be remembered what preparations were made and precautions taken for the transport of the great bell to St. Paul's, and the difficulty of its hoisting and hanging; and now being hung, it would be dangerous to swing its enormous weight—some eighteen tons. Mr. Hoffman, of 54, Junction-road, N., has invented a bell which he claims will obviate all these difficulties. The Hoffman bell is not cast, but made of metal, bent or spun to shape. A bell may be made in several pieces and hard soldered together. The peculiarity of the result obtained by Mr. Hoffman is that his bells give an astonishing volume of sound. We have heard a bell weighing but 3½ lb. which gives quite as much sound as a cast bell of ten times the weight, and the tone is very pure and true. The vibrations last twenty-five seconds, and the overtones or harmonics are quite perceptible. The inventor guarantees to produce a bell weighing 1 ton which shall be as musical and as efficient as an ordinary bell of 20 tons. Various attempts have been made to use sheet metal for bells, but they have all failed hitherto; and the reason why Mr. Hoffman has attained an unprecedented success seems to be that he has hit on a peculiar alloy, which appears, so far as we can see, to possess some remarkable properties. It is well known that ordinary bell metal is hard and brittle. Mr. Hoffman has, however, discovered a method by which a bell metal is produced which will be resonant in a very high degree but admits of being bent. It bears, that is to say, about the same relation to ordinary bell metal that malleable cast iron bears to ordinary cast iron. Although Mr. Hoffman is confident that he can produce very large bells in this way, he has not made any, and it remains to be seen how far he will be successful; but he has done enough already to excite the interest and claim the attention of every campanologist.

LITERATURE.

Arc and Glow Lamps. A Practical Handbook on Electric Lighting. By Julius Maier, Ph. D. Whitaker and Co. and George Bell and Co., London, 1886.

This is an octavo book of 375 pages, very much resembling in most respects any one of the better class of the numerous books on electric lighting which have been published within the last few years. At the outset we protest against the substitution by Dr. Maier of the term "glow" for incandescent. In the first place, it is bad English; in the second, nothing whatever can possibly be gained by the substitution; and lastly, it tends to confusion. Not long since we heard the term used as a reproach concerning a faulty installation. "The lamps," said a witness, "did not give a proper light, only a glow." The word glowing does not express intensity of light, but rather a subdued light, such as an incandescent lamp properly used certainly does not give out.

Dr. Maier, as a matter of course, begins with the mathematics of electricity, to which, as he covers old ground, we cannot take any exception. On the whole, this portion of the book is satisfactory. The weak portions of the work are to be found where the author has dealt, or tried to deal, with practice, and we can find, on almost every page, omissions which might be seriously misleading. For example, on page 31 we have the following:—"An arc lamp of average illuminating power requires an electro-motive force of 50 volts. and 10 ampères current; a 20-candle Swan lamp of 133 ohms resistance takes 100 volts and ·75 of an ampère. Provided now that the conducting wires are sufficiently strong (*sic*) for the required current, it is clear from the above figures that we can substitute two arc lamps in series for each glow lamp, and that it is possible to run arc and glow lamps in the same circuit from the same dynamo, on condition, however, that through some arrangement in the dynamo, the difference of potential in the conductors is kept constant." This is right so far as it goes, but it does not go far enough, and neither here nor elsewhere in the book does Dr. Maier say one syllable concerning the practical difficulties which the electrician has to encounter when he attempts to run arc and incandescent lights on the same circuit; difficulties mainly connected with the fact that the resistance of the arc lamp is always changing, and that it is impossible to construct a dynamo which will *anticipate* these changes, the result being in practice that the least imperfection in the action of the arc lamps, due to one or more of a number of causes, renders the light given by the incandescent lamps variable in intensity. The variations may be small and of extremely short duration, but they are quite sensible, and for this and other reasons the practice of working both systems on the same circuit has never come into use, save under very exceptional conditions, and probably never will. We are disposed to doubt as we read that Dr. Maier knows much about arc lamps, to which a very large portion of the book is devoted. He writes, at all events, very loosely about them. "The large illuminating power of the arc lamp, which naturally limits the number of lamps to be employed even for a comparatively large area, and further, the fact of their taking a relatively small electro-motive force—50 volts—makes it possible to run a considerable number of them in series in the same circuit." This is all very well, except for the circumstance that it is the aggregate high electro-motive force required that practically limits the number of arcs that can be used, and this fact appears to dawn later on, on our author, who says in the succeeding paragraph—"The electro-motive force in this case must be in proportion to the number of lamps; so, for instance, if ten lamps of 50 volts each are connected in series, the electro-motive force of the dynamo must be $10 \times 50 = 500$ volts. Fifty lamps, as is sometimes the case in America, connected in series, would require 2500, a tension which is positively dangerous, and ought on that score to be forbidden by law." Thus, then, it will be seen that notwithstanding the first paragraph we have quoted, the number of arc lamps which can be put in one circuit is very limited. Perhaps Dr. Maier has a different idea of a "considerable number" from that which we form. After adding that the wires need not be large for series arc lighting, he goes on to say that: "The drawback to the system lies in the fact that the individual lamps are not independent of each other." This is flatly opposed to fact. In proper systems of arc lighting the lamps are, or ought to be, quite independent of each other. It is the essence of the shunt feed lamp, fitted with a good cut-out, that it may be quite independent of every other lamp in the circuit. If it is not, that is the fault of the lamp maker.

The chapter on electrical measurements is very satisfactory, good descriptions and illustrations being given of all the better known instruments in use for measuring both quantity and intensity. The section on installations contains some curious statements. For example, we are told that the gas and water pipes may be used as return leads. Possibly Dr. Maier is better informed concerning what is done abroad in this respect than we are. But in this country electricians have never been able to make "earth" a satisfactory substitute for the return wire.

Our author devotes a great deal of space to a description of a large number of arc lamps, but he has not written critically concerning any one of them. In this respect, however, he is neither better nor worse than any other writer on the subject. There is, indeed, a total lack of intelligent literature concerning arc lamps, which are really entitled to rank among the most curious pieces of mechanism ever devised. We have not space to explain here in detail the way in which Dr. Maier is in fault. It will suffice if we give one or two examples. There are certain lamps which are generically styled "clutch" lamps, because the carbons are held apart by a friction clutch. This clutch is operated on by the shunt solenoid core in such a way that when the carbons get too far apart the pressure of the clutch upon the carbon carrying rod is relaxed, and the rod descends a certain distance until it is gripped again. Now, it is well known that there is no clutch lamp made which gives an absolutely steady light, a fact never mentioned by Dr. Maier, and the reason why is simply that the statical friction between the clutch and the carbon carrier is greater than the friction of motion, and consequently the lamp always feeds by jerks, the length of each drop being a variable quantity. To make what takes place clearer, let us suppose that the pressure of the clutch on the rod is represented by 10, and that this just suffices to keep the rod at rest. Now the pressure is reduced to 9 by the lengthening of the arc, and the carbon drops. The moment the arc is restored to its proper length, the brake is reapplied with a force of 10; but this will not now suffice to restrain the rod. In the first place, it is moving, and the dynamical friction between it and the brake is much reduced; and in the second, it has acquired a certain *vis viva*. The end of all this is that the top carbon must approach the bottom carbon, until a point is reached at which the brake acts with a force of 12 or 13 before it can be stopped. This, of course, alters the light, not only in intensity, but in distribution, because a long arc distributes better than a short one, the angle subtended by the lower carbon being reduced. So imperfect, indeed, is the clutch, that the carbon cannot be left to its tender mercies, and a glycerine dash pot or similar device—the abhorrence of practical electricians—has to be used to retard its progress and give the clutch time to act. Not a syllable does Dr. Maier say in the way of criticism or explanation about this.

Again, in certain clockwork lamps, the last spindle in the train carries a star wheel. Close to this is fitted a detent, which is dropped into gear with and stops the train, and prevents the further descent of the carbon. When feeding is necessary the detent is raised and liberates the star wheel. Now this is at first sight a very taking device, but it has an irremediable defect. When the top carbon is on the point of being liberated the detent has been so far raised that it stands close to the extremity of a tooth of the star wheel. This wheel revolves at a considerable speed when it is released, and when the detent is being restored after the carbon has fed sufficiently, it gears the star wheel to so small a depth that it is jerked out by the teeth. In clockmakers' phrase, it "trips," and over-feeding is the result. In the Gramme lamp shown at Antwerp last year this objection was quite overcome, and the lamp worked very well indeed. But Dr. Maier says nothing of all this. He contents himself with describing certain lamps, and for the most part speaks kindly of them all, but he has apparently no perception whatever of the mechanical fitness or the reverse of any lamp.

Furthermore, he is by no means either accurately or fully informed about arc lights. Thus, we find him stating, without any qualification whatever, that the all-important thing in an arc lamp "is the maintenance of the carbon points at a certain constant distance, so as to preserve a constant resistance of the arc." Now this is only true within certain limitations. The object to be had in view is to maintain that resistance which will give a steady light, and this may vary as different portions of the carbon come to be burned. Again, we gather that Dr. Maier does not know that the resistance of an arc generally *diminishes* as it augments in length. This is the reason why, if a lamp is cut out of a series actuated by a non-compound dynamo, most of the other lamps will refuse to feed, lengthening their arcs to the point of flaring. Nor can we agree with Dr. Maier when he sweepingly condemns all arc lamps by the assertion, "We may safely say that even in the best arc lamps the performance is yet very far behind the requirements, and if such is the case, even in lamps of good workmanship, what will be the result with lamps of inferior make?" Anyone who saw how the Thompson-Houston lamp worked last year at the Inventions Exhibition, and Brockie's lamp about four years ago at the Crystal Palace, must know that lamps have been made which will give for hour after hour a steady light without a trace of flickering. The performance of these lamps is certainly not "very far behind the requirements," and were it necessary, we could name lamps by other makers not less excellent.

Dr. Maier has written a very interesting chapter on the manufacture of carbons for arc lamps, which contains some new information concerning which we regret we have not room to speak. It is a noteworthy fact that he styles Wedermann's semi-arc a "glow" lamp.

The section on incandescent lamps is, perhaps, the best portion of the book. The author has collected all the most recent available information concerning the process of manufacture, life, &c., of these lamps in a very convenient and readable form. Indeed, we do not know any work in which the subject is, on the whole, so fully handled. There is a chapter on secondary batteries; the electric light in collieries, and, near the end, a short description of the photographic arrangements adopted by M. Dujardin, of Paris, from which we gather that that gentleman has still something to learn on the subject.

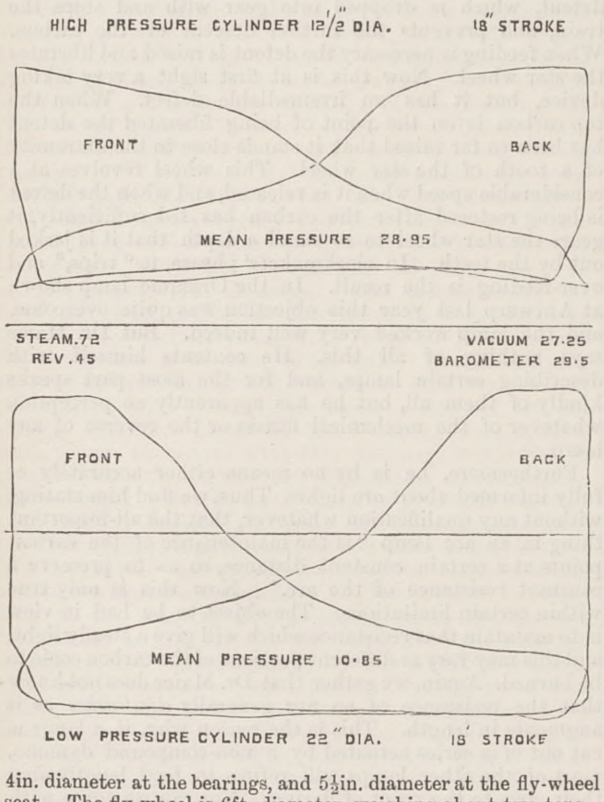
We have pointed out the blemishes in Dr. Maier's book, but the space we have devoted to it is sufficient evidence that we consider it an important work of its kind. The worst of the whole is that the author keeps his own opinions too much in the background, giving the impression either that he has none, or that he lacks confidence in himself. The result is that the book reads all through too much like a mere compilation, which, however, it really is not. It may be read with advantage by students, and electrical engineers will find in it a great deal of cut-and-dry information provided ready to their hands. The comparative absence of complex formulæ is no small recommendation.

PUMPING ENGINES, STOCKTON-ON-TEES WATERWORKS.

On page 190 we illustrate a horizontal compound surface condensing pumping engine, which possesses several novel details and will be of interest to our readers. The engines were designed and constructed by Messrs. Worth, Mackenzie, and Co., of Vulcan Engine Works, Stockton-on-Tees, to the order of the Stockton and Middlesbrough Corporations Water Board, for their Eston Pumping Station, where they are required to pump direct from the company's main service and deliver to a reservoir situated on the Cleveland Hills, about two miles and a-half distant from and 245ft. higher than the pumping station.

The engines are of the intermediate receiver type, with cranks at right angles, the main feature of the design being the arrangement of the steam cylinders and pumps, which are overhung from opposite ends of deep bed plates, the crank shaft being placed between the cylinders and pumps. This design gives a very compact engine, convenient of access to every portion of the engine, and in particular to the pistons and pump valves; as either steam or pump pistons can be taken out without disturbing any other part of the engine, except the cover of the piston requiring examination.

Both ends of the bed plates are faced and turned at one setting, thus ensuring the true alignment of the cylinders and pumps without hand labour. There is a hollow space at the steam cylinder end of each bed plate, which is packed with hair felt to prevent the transmission of heat. The cylinders are respectively 12½in. and 22in. diameter, and the pistons have a stroke of 18in.; the latter are 4in. deep, and fitted with broad cast iron packing rings. The piston rods are of Bessemer steel, 2¼in. diameter, secured to both pistons and cast steel crossheads by cones and nuts. There are similar steel crossheads on the pump piston rods, but made with double eyes to take the connecting rods; and t ese crossheads are connected to those on the steam pistons by polished wrought iron coupling rods, the arms of the crossheads being made of sufficient length to allow the coupling rods to clear the cranks. The connecting rods are of wrought iron, and return from the pump crossheads to the cranks, which are placed near the steam cylinder ends of the bed plates. The cranks are of steel, cast solid with the crank pins, and together with the other steel castings were supplied by Messrs. Butler Brothers, of Middlesbrough. The crank shaft is of forged steel,



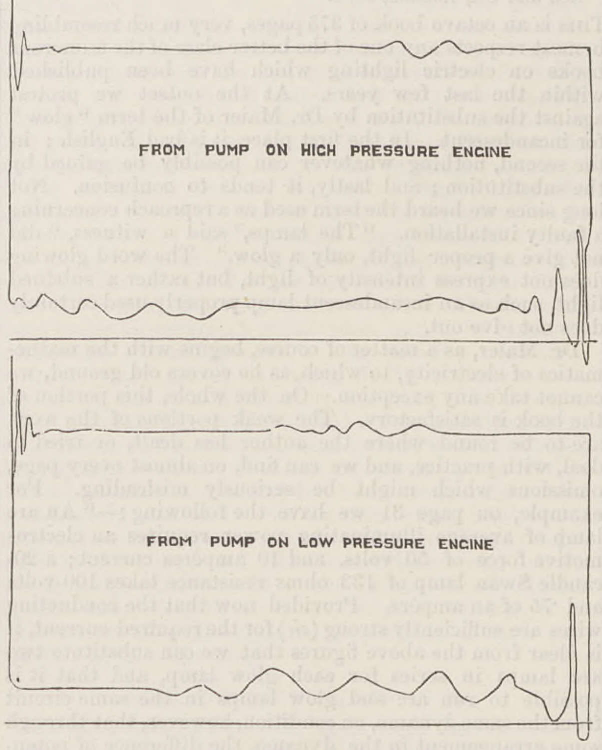
4in. diameter at the bearings, and 5½in. diameter at the fly-wheel seat. The fly-wheel is 6ft. diameter, weighing about two tons.

The pumps are double-acting, being of cast iron with a gun-metal liner 6in. inside diameter by ½in. thick, and are fitted with gun-metal valves and seats. Each delivery valve is placed directly over the corresponding suction valve, and is made as much larger in diameter as will allow the latter to be withdrawn without disturbing the delivery valve seat. The valve covers are each secured by four bolts, and jointed by a ring of lead-wire, which does not require renewal when the valves are examined. The pump pistons are of gun-metal, and are secured to the pump rods by nuts and check nuts; the packing rings are deep, and pass a little beyond the brass liner at both ends of the stroke, thus preventing any ridge being left in the liner as it wears.

In the surface condenser, which is arranged beneath the floor-line, the steam passes through the tubes, the whole of the water being pumped passing around them. On the top of the condenser there is placed a feed heater, through the tubes of which the exhaust steam first passes, while the feed-water on its way to the boiler, circulating around them, is raised in temperature about 60 degrees. The air pump is of cast iron, with gun-metal valves and seats, and is of somewhat novel construction, being made open-topped, so that access to the pump packing can be obtained without breaking any joint. It is driven by bell-crank and levers from the pump crosshead of the low-pressure engine, and an unusually good vacuum has been obtained with this pump, being always within two inches of the barometer.

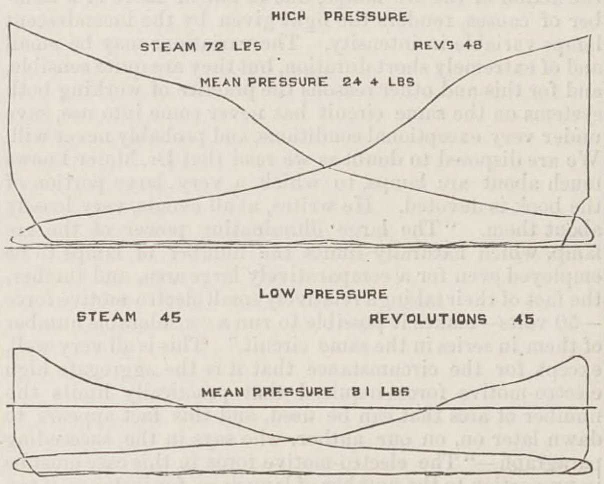
The feed pump is bolted to the top of the hot well, and the air charging pump is inverted over the feed pump, both rams being made in one casting, which is of gun-metal, driven from an excentric on the main shaft. The air charging pump draws from a bell-mouthed cup, into which a little water is allowed to drop, which both cools and lubricates the pump ram, and entirely prevents the escape of air past the pump packing. For the distribution of steam each cylinder is provided with a separately adjustable expansion valve, working on the back of the main valve, and the diagrams which we give herewith, show that an exceedingly good result has been obtained. The boiler for driving these engines is of the ordinary Cornish type; but the dimensions were partially determined by the size of the existing boiler house. The shell is 5ft. diameter by 12ft. long, made of B.B. iron; the flue and end plates are of Weardale steel, the former being 2ft. 6in. diameter, with Adamson expansion joints and four Galloway tubes. The safety valves are set to blow off at 75 lb. per square inch.

The contract with Messrs. Worth, Mackenzie, and Co., for the building and erection of this machinery, provided that the cost for fuel per 1000 gallons of water delivered into the reservoir should not exceed ·18 of a penny, under the heavy penalty of £30 for every hundredth part of a penny in excess, the coal used to be Morley rough small, at 7s. 3d. per ton; and the water to be measured as actually delivered into the reservoir. The trial, in charge of the Water Board's own officials, took place on the 30th and 31st of March last, when the cost of pumping was returned by them at ·153 of a penny, or about 15 per cent. under the guarantee, and equivalent to a duty of over 72 millions per 112 lb. of coal consumed. The coal used was a fair description of North-country engine small, but had—we are informed—suffered much detriment through exposure to very



bad weather for over a month previous to the trial, and would, under the circumstances, be greatly inferior to the best Welsh coal, which is generally used in pumping engine trials.

Taking this into consideration, we are not aware that this duty has ever been exceeded in a pumping engine of so small a power, and compound engines of this simple type will commend themselves for the water supply of towns of moderate size. The annexed diagrams were taken from the high-pressure and the low-pressure cylinder working separately on two different days. As the contract for these pumps also provided that the high-pressure



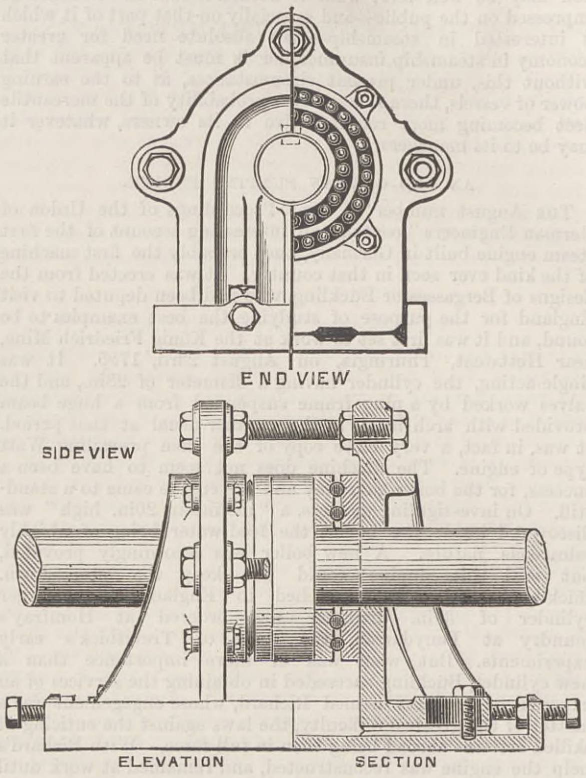
engine should be capable of being worked alone as a non-condensing engine, and the low-pressure engine alone as a surface-condensing engine, it was resolved to carry out a short trial of each under the above conditions, and we give indicator diagrams of these trials, with a tabulated result, together with the result of the official trial under ordinary working conditions. The design was approved by Mr. J. Mansergh, M.I.C.E., engineer to the Board, and the contract carried out under his superintendence.

Stockton and Middlesbrough Corporations Water Board. The following are Detail Results of Eston Pumping Engine Trials.

	Both engines working together as compound surface-condensing intermediate receiver engines. Feed-heater in use.	Low-pressure engine running alone as single-cylind'r surface-condensing engine. Feed-heater in use.	High-pressure engine running alone as non-condensing engine. Cold feed-water.
Date	30th & 31st of March, 1886.	22nd of April, 1886.	23rd of April, 1886.
Duration of pumping	21½ hours	6 hours	8 hours.
Coal used per hour	80 lb.	65·33 lb.	75·25 lb.
Boiler pressure	72 ,,	44 ,,	70 ,,
Initial cylinder pressure ..	65 ,,	9 ,,	55·5 ,,
Ratio of expansion	7	3·05	3
Head against which pump worked	254ft.	209ft.	195ft.
Gallons of water pumped ..	436,675	61,419	82,287
,, ,, per hour	20,310	10,236	10,286
Duty per cwt. of coal	72,222,360	36,674,126	29,853,321
Capacity of pumps	7·362	3·681	3·681
Delivery per revolution ..	7·025	3·5125	3·5125
Efficiency of pump	95 per cent.	95 per cent.	95 per cent.
Coal burnt per 1000 gallons lifted	3·943 lb.	6·382 lb.	7·316 lb.
Indicated horse-power	30·99	14·61	13·3
Cost of coal per 1000 gallons at 7s. 3d. per ton	·153d.	·2478d.	·2841d.
Cost of coal to deliver 1,000,000 gallons..	12s 9d.	£1 0 8	£1 3 8
Cost of oil, &c., per 1000 gals.	·02d.	·04d.	·03d.
Cost of coal and oil per 1,000,000 gallons..	14s. 5d.	£1 4 0	£1 6 2

BELL'S SCREW SHAFT BALL BEARING.

The ball-bearing illustrated by the engraving below has been designed by Mr. L. B. Wells, of Highfield, Northwich, for the thrust-bearing on screw shafts. The engravings explain the



construction, and the bearing may be seen on Stand 402, Liverpool Exhibition. The screw shafts of the steam tug Volunteer and of the steam launch Delamere have been fitted with it, and the figures obtained from trials of these are published by the inventor.

PRIVATE BILLS IN PARLIAMENT.

Following a precedent set in 1880, on June 17th last the expiring Parliament passed a standing Order under which the Private Bills not yet completed should be suspended in order to be taken up again at the point where they were then left, in the next session of Parliament. Considering how far many of the Bills still before Parliament had advanced, this was a most important concession to the promoters of these various schemes, inasmuch as, but for this Order, their Bills would have become dead, and if revived in the following session would have to begin *de novo*, this involving a serious pecuniary sacrifice. Lawyers and agents might not be over pleased with this arrangement, but to those who had to provide the money for these measures the special order was more than welcome. By great exertions, prompted by the fear of an early dissolution of Parliament, nearly one hundred of the total Bills promoted last session were disposed of and received the Royal Assent. A certain number of the Bills had either been thrown out or had lapsed, and there remained fifty to be carried over to the present session. Of these, thirty-five had originated in the House of Commons, and twenty-seven of the thirty-five had passed through the House and been sent up to the Lords. These were the Barnet District Gas and Water; Bridgewater Railway; Carlisle Corporation; Exeter, Teign Valley, and Chagford Railway; Halifax High Level Railway; Hampstead Heath Enlargement; Hillhead and Kelvinside—Annexation to Glasgow; Leeds Compressed Air Power Company; London Street Tramways; Lynton Railway; Manchester, Sheffield, and Lincolnshire Railway; Mersey Railway; Midland and South-Western Junction Railway; Nelson Local Board; North London Tramways; North Pembrokeshire and Fishguard Railway; Ormskirk Railway; Plymouth and Devonport Extension Tramways; Plymouth and Devonport District Tramways: River Suck Drainage; Rotherham and Bawtry Railway; St. Helen's and Wigan Junction Railway; Salford Corporation; Seacombe, Hoylake, and Deeside Railway; Skegness Chapel; St. Leonard's and Alford Tramways; Southend Local Board; and Sutton and Willoughby Railway Bills. Of the fifteen Bills left over that had originated in the House of Lords, not one had passed down to the Commons, only one had been considered and ordered to be read a third time, ten had been read a second time and committed—viz., the Ardrossan Harbour, Barry and Cadoxton Gas and Water, Clyde Navigation, Edinburgh Improvement, Kensington Vestry, Moore-street Market and North Dublin City Improvement, Muswell-hill Estate and Railways, Rhymney Railway, Warehousemen and Clerks' Schools, and Woodstock Railway Bills. This being the position when the present Parliament assembled, the question was at once raised as to what course would be adopted. In view of the limited programme presented to Parliament in her Majesty's Speech, it was evident that there was little chance for opposed and contentious Private Bills; but obvious as that was, something like a disagreement arose between the two Houses. The respective chairmen of Private Bills in the Lords and Commons, the Duke of Buckingham and Mr. Courtney, decided that both opposed and unopposed Bills would be proceeded with—it being, however, left optional with Parliamentary agents to go on with their Bills or not. Subsequently an intimation was circulated that the Government were unwilling to consent to any opposed schemes being taken up, though quite ready to forward unopposed Bills. On the other hand, the Lords were understood to favour the further consideration of opposed measures, and to be willing to appoint Select Committees for that purpose. Later on the General Committee of the House of Commons on Railway and Canal Bills met, under the presidency of Sir Richard Paget, to finally determine the course of procedure, and in the end they resolved that unless it could be shown that any person would be injured by delay, they would not take up any opposed business this session, but would leave such business to stand over till next year without further cost to the parties. In the meanwhile, the Lords had appointed a Select Committee of five to deal with any opposed measure, and this Committee may possibly proceed with any such Bills, while the session lasts. It is not, however, likely that any but unopposed Bills will now be brought up in either House; but a certain number of schemes, over which there is little controversy, will pass into law before the prorogation. In the House of Commons on Monday last the Standing Orders

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, Aug. 21st.

The makers of Southern iron have been making special efforts during the past week to secure contracts for large deliveries during autumn and winter. Brokers have been solicited to transfer their patronage from Northern to Southern furnaces, under the representation that the Southern quality has been improved greatly and is uniform, and can be relied upon for foundry and forge purposes. The Southern pig iron markets have certainly improved, but are yet behind the requirements. Last year's consumption of pig iron in the New England States was about 100,000 tons; this year's consumption will be a little more. Large contracts have been placed in Western markets for Southern iron, but it is not likely that this iron will meet with the same favour in the East because of the convenience of Lehigh irons in Eastern Pennsylvania. The makers of crude iron in Middle and Eastern Pennsylvania are on the ground looking after their interests, and will meet Southern competition successfully. Two furnaces have been blown out this week and two more blown in, leaving the production, according to recent estimates, in Western Pennsylvania about 122,000 or 123,000 tons per week. Rails are in active demand at 34 dols. to 35 dols. To-day's reports from Pittsburgh show that a sharp improvement in demand for bridge and plate iron has set in, that the pipe mills are oversold, that orders for rails are coming in at 35 dols. 50c., and that the blast furnaces are all well sold up. Advices from Ohio, Indiana, and Illinois iron centres show a correspondingly favourable condition of things. Agricultural implements are in good demand for shipment to the further West agricultural regions. Tool steel is selling well; and, in fact, all kinds of merchant steel is in fair demand. The position in the iron trade is one of satisfaction to manufacturers and dealers. Forge iron is selling in Eastern and Western Pennsylvania markets at 16 dols., Bessemer at 18 dols. Heavy contracts have been placed this week for iron ore.

NEW COMPANIES.

The following companies have just been registered:—

Arauco Company, Limited.

This company proposes to take over a concession dated 23rd October, 1884, from the Government of Chili to Don Gustavo Lenz, of the railway from the City of Concepcion to Los Rios de Curanilahue in Chili, with the State guarantee of interest thereby given; also to construct, equip, and work such railway and other public or private works in the province of Arauco or elsewhere in Chili. It was registered on the 23rd ult. with a capital of £250,000, in £10 shares, of which 12,500 are preference shares, and will be entitled to a cumulative preferential dividend of 5 per cent. until the railways are completed, and afterwards at the rate of 10 per cent. per annum. The subscribers are:—

	Preference Shares.
Colonel J. T. North, Avery-hill, Eltham	1
*E. Edmonson, 60, Castle-street, Liverpool, merchant	1
*Robert Fowler, 6, Lombard-street, engineer	1
G. Hicks, Newquay, Cornwall, nitrate manufacturer	1
John Abbott, 55, Lee Park, Blackheath, engineer	1
*H. H. Nicholson, Exchange-buildings, Liverpool	1
B. Arkle, 15 and 17, King-street, Liverpool, banker	1

The number of directors is not to be less than three nor more than seven; qualification, 100 preference or 200 ordinary shares; the first are the subscribers denoted by an asterisk; the company in general meeting will determine remuneration.

Calder Vale Room and Power Company, Limited.

This company was registered on the 24th ult. with a capital of £10,000, in £50 shares, to purchase the weaving shed and premises situate in Calder Vale-road and Ashfield-road, Burnley, Lancaster, known as the Calder Vale Shed. The subscribers are:—

	Shares.
T. Burrows, Burnley, cotton manufacturer	1
W. Brierly, Burnley, cotton manufacturer	1
W. Burrows, Burnley, cotton manufacturer	1
W. Barker, Burnley, taper	1
J. Ralph, Burnley, beamer	1
J. Dyson, Burnley, butcher	1
J. Moore, Burnley, fruiterer	1

Most of the articles of Table A of the Companies' Act, 1862, apply to the company.

Moel Hebog Copper Mining Company, Limited.

This company was registered on the 20th ult. with a capital of £25,000, in £1 shares, to acquire and work the Moel Hebog Copper Mine, Carnarvon. The subscribers are:—

	Shares.
D. Troman, Coventry-road, Birmingham, manufacturer	10
W. H. Pride, 26, North John-street, Liverpool, solicitor	1
J. Warry, Birkenhead, accountant	10
S. E. D. White, 20, South John-street, Liverpool, estate agent	10
J. Craig, 34, South John-street, Liverpool, engineer	10
W. Troman, Solihull, Warwick, manufacturer	10
J. Bell, 69, Renshaw-street, Liverpool, French polisher	1

Table A will apply to the company. Messrs. J. Craig and Co., of 34, South John-street, Liverpool, are appointed consulting engineers to the company at such remuneration as the directors may determine, provided that £100 per annum be the minimum.

Central Transvaal Gold Mining Company, Limited.

This company proposes to carry on mining operations in the South African Republic, but no mention is made in the memorandum of association of the particular properties to be taken over. It was registered on the 19th ult with a capital of £75,000, in £1 shares. The articles of association provide for the adoption by the company of an agreement, but the promoters have not yet registered this document, neither have they furnished any particulars as to its contents. The signatories, who render themselves liable for £1 only, are as follows:—

	Shares.
James Bacon, 79, Queen-street, secretary to a company	1
F. Gowlett, 11, Queen Victoria-street, stationer	1
G. Holmes, 11, Queen-street, stationer	1
J. Kenny, 50, Bow-lane, engineer	1
A. Salter, 60, Kiver-road, Upper Holloway, warehouseman	1
C. Montague, 1, Risinghill-street, Islington, clerk	1
J. Meeking, Mann-street, Surrey-square, contractor	1

The number of directors is not to be less than three nor more than ten; the subscribers appoint the first; qualification for subsequent directors, 200 shares; the company in general meeting will determine remuneration. The directors are empowered to appoint from their number a managing director or managing directors, for such period and at such remuneration as they may think fit.

South Wales and Monmouthshire Boiler Insurance Company, Limited.

This company proposes to insure boilers, engines, machinery, plant, buildings, and other property against loss or damage arising from the explosion of steam boilers or the collapse of the flue tubes thereof, and to insure owners of steam boilers against loss occasioned under the Employers' Liability Act, 1880, or otherwise. It was registered on the 23rd ult. as a company, limited by guarantee to £1 each member, and also with a capital of £100,000 in £5 shares. The subscribers are:—

	Shares.
*John Glasbrook, Swansea, colliery proprietor	50
*C. L. Bath, Swansea, copper works manager	50
*C. J. Cory, Cardiff, colliery proprietor	50
H. J. Goss, Swansea, chartered accountant	10
R. Capper, Swansea, railway manager	20
James Inskip, Bristol, solicitor	20
C. Price, Swansea, sub-manager Swansea Bank	20

The number of directors is not to be less than five nor more than thirteen; qualification, fifty shares; the first are the subscribers denoted by an asterisk, and Messrs. Thomas Cory of Swansea, E. Jones of Varteg, and Wm. Thomas of Brynawel, near Aberdare. The company in general meeting will determine remuneration.

Viola Company, Limited.

This company was registered on the 23rd ult. with a capital of £150,000, in £1 shares, to acquire the property, rights, powers, and privileges of the Viola Mining and Smelting Company of Colorado. The subscribers are:—

	Shares.
W. B. Chapin, 12, Great Portland-street	1
W. H. Reynolds, Lombard House, George-yard, merchant	1
Clarina Shaw, Lombard House, George-yard, secretary	1
Percy Walker, 15, Cloudesley-street, N., stationer,	1
P. W. Evennett, 161, Clarence-road, Clapton	1
J. K. Fox, 24, Lucretia-road, Kennington	1
J. D. Ayers, 6, Old Jewry, agent	1

The number of directors is not to be less than three nor more than seven; qualification, 100 shares; the subscribers are to appoint the first and act *ad interim*; remuneration, £200 per annum to each director, and 5 per cent. on the surplus profits after payment of 10 per cent. dividend.

St. Lawrence Corporation, Limited.

This company was registered on the 24th ult. with a capital of £100,000, in £1 shares, to acquire the lands and estate known as the Mille Vaches Estate, situate in the county and district of Saguenay, province of Quebec, Canada, bounded in front by the river St. Lawrence, and behind by the public domain, on the south by the township of Iberville, and on the north by the township of Laval, with the timber, mines, mills, and buildings thereon; also to acquire and undertake all or part of the assets and liabilities of the Dominion of Canada Freehold Estate and Timber Company, Limited. The subscribers are:—

	Shares.
*Shackleton Hallett, 1, Hare-court, Temple, barrister	1
S. C. Fox, Enfield, accountant	1
T. Brown, Cowper's-court, Cornhill, broker	1
W. Elliott Duncan, 57, Basinghall-street, colliery owner	1
C. J. Langton, 54, Cannon-street, surveyor	1
*E. H. Tamplin, 14, Smith-street, S.W.	1
Robert Parker, 32, King-street, surveyor	1

The number of directors is not to be less than three nor more than seven; qualification, £100 in shares or debenture stock; the first are the subscribers denoted by an asterisk, and Messrs. M. M. Moore, H. W. Spratt, and Major-General E. J. Wild. The remuneration of the board will be at the rate of £100 per annum for each director.

Messina Provincial Roads Railway Company, Limited.

This company was registered on the 20th ult. with a capital of £200,000, in £10 shares, to construct, equip, and work railway and tramways, but no mention is made in the memorandum and articles of association of the particular work to be undertaken by the company. The subscribers are:—

	Shares.
F. Mauelle, 101, Leadenhall-street, merchant	1
J. Kerr, 101, Leadenhall-street, contractor	1
G. H. Carr, 101, Leadenhall-street, clerk	1
J. H. Chapman, 61, Wellington-street, Woolwich, clerk	1
W. H. Adams, 30 Peckham-grove, accountant	1
*A. Mattei, LL.D., 3, Plowden-buildings, Temple, barrister	1
T. Floyd, C.E., 3, Victoria Mansions, S.W.	1

The number of directors is not to be less than six nor more than eight; the first are the subscribers denoted by an asterisk and Messrs. John Holms, F.R.G.S., director of the Union Bank of London; Baron Ernesto Cianciolo, President of the Banca Siciliana; Antonio Melardi, Enrico Gazzera, J. Fyfe Meston, and such other persons as the subscribers may appoint. From the first ordinary general meeting in 1889 the necessary qualification for a director will be the holding of fifty shares. The remuneration of the board will be £200 per annum for each director, but until a complete railway, road railway, or tramway of the company shall be open for traffic, no fees will be payable. The board will also be entitled to 5 per cent. of the net earnings whenever, after paying 10 per cent. dividend, such net earnings shall be sufficient.

Ystalyfera Iron and Tin-Plate Company, Limited.

This company was registered on the 23rd ult. with a capital of £50,000, in £50 shares, to acquire the business and property of the Ystalyfera Company, Limited, at Ystalyfera, Glamorgan, and to issue fully paid shares of the nominal value of £2800, in part payment of the purchase consideration. The subscribers are:—

	Shares.
Lieut.-Colonel F. Faulkner Sheppee, Chester-le-street, Durham	1
C. Fisher Clark, M.E., Wigan	1
D. Morgan, Ystalyfera, contractor	1
T. Morgan, Ystalyfera, merchant	1
W. Williams, Ystalyfera, accountant	1
J. T. Newton, C.E., Mumbles	1
J. R. Coble, Brecon, solicitor	1

The number of directors is not to exceed seven; the subscribers are the first; qualification for subsequent directors, 20 shares; the company in general meeting will determine remuneration.

THE LUIZ I. BRIDGE AT OPORTO.[1]

The following is an abstract of a paper by T. Seyrig, M. Inst. C.E., in the "Memoires de la Société des Ingénieurs Civils," Paris, 1886, p. 38:—

"The river Douro would seem to constitute a fruitful site for the erection of great engineering works. After a lapse of eight years, the first celebrated bridge, with central arch of 525ft. span, and of great height,[2] has been followed by a second example, apparently similar, but really presenting many features of difference when closely examined. Its most notable peculiarity is that a single arch of 566ft. span provides two separate passages in the same vertical plane, of which the upper road is at a level of 164ft. above the lower one. This somewhat mars the bold effect of the work, but it serves to solve the somewhat difficult problem of intercommunication between the different levels of the town. The author, who designed both structures, gives a summary of the various plans submitted in competition for the later bridge, insisting on the propriety of endeavouring in such works to harmonise economy and the exigencies of good construction with pleasing and even artistic aspect. This attention to artistic effect he claims as a characteristic of the French school of engineering.

"The arch of the Luiz I. bridge is so far the largest existing, and will doubtless remain so until the completion of the Forth bridge. It weighs, with its two roadways, about 20 tons per lineal metre of span—6 tons per foot. The arch rests on rollers, and its form is the opposite of that of the earlier bridge; that is to say, it is narrowest at the crown, instead of being crescent-shaped. The theoretical considerations which led to this change are discussed at length by the author, but the principal reason was the obligation of allowing the lower roadway to pass between the springings of the arch, while assuring the transmission to the masonry piers of the wind stresses—that is to say, without interrupting the continuity of the cross-bracing. This difficult condition is asserted to have been satisfactorily met. The width of each roadway is 26ft. 3in.; the upper road is at a height of 204ft. above the river; it is paved with wood and is laid with a tramway. The lower road is macadamised. The total weight of metal in the structure is about 3200 tons, and its price will amount to nearly £100,000.

"The most important part of the paper relates to the mode of erection. The author adopted a novel system, consisting in the employment of wire cables, by which the various parts were raised from barges moored in the river below, and assembled in their proper positions by manœuvres executed entirely from the side piers. This funicular system resulted at once in safety, rapidity, and great economy. The ironwork was constructed at the works of the Société de Willebroeck, and the excellent workmanship conduced greatly to render the erection easy and economical."

New Method for Protecting Iron.—A new method, which promises to be easier of application than any previous, has been lately brought out by M. A. De Meritens, the well-known electrician, and if it succeeds as well in the hands of the public as it does with the inventor, should find a very extended application. The article to be protected is placed in a bath of ordinary or distilled water, at a temperature of from 70 deg. to 80 deg Cent. — 158 deg. to 176 deg. Fah. — and an electric current is sent through. The water is decomposed into its elements, oxygen and hydrogen; and the oxygen is deposited on the metal, while the hydrogen appears at the other pole, which may either be the tank in which the operation is conducted or a plate of carbon or metal. The current has only sufficient electro-motive force to overcome the resistance of the circuit and to decompose the water, for if it be stronger than this, the oxygen combines with the iron to produce a pulverulent oxide which has no adherence. If the conditions are as they should be, it is only a few minutes after the oxygen appears at the metal before the darkening of the surface shows that the gas has united with the iron to form the magnetic oxide Fe_3O_4, which it is well known will resist the action of the air and protect the metal beneath it. After the action has continued an hour or two the coating is sufficiently solid to resist the scratch brush, and it will then take a brilliant polish. The process is simple, and demands but little skill in its execution. Now that dynamo machines have superseded batteries as sources of electricity, all that is required is a tank, a quantity of distilled water, and a little power to drive the machine.—*Scientific American.*

1 "Proceedings," Institution Civil Engineers.

2 Minutes of "Proceedings" Inst. C.E., vols. li., p 302; lxiii., p. 177, and The Engineer.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Applications for Letters Patent.

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

24th August, 1886.

10,774. Refrigerating Apparatus, T. Fishburn, London.
10,775. Cutting Garments out of Textile Fabrics, H. Willey, London.
10,776. Revolving Trucks, S. S. Bromhead. — (*A. Legrand, France.*)
10,777. Harvesting Machinery, J. Hornsby and J. Innocent, Grantham.
10,778. Spring Winding and Driving Power for Bicycles, &c., J. Cheshire, Birmingham.
10,779. Valves for Pumps, &c., S. P. Blackburn, London.
10,780. Sectional Boilers, J. F. and J. H. Allen, London.
10,781. Transfer Surfaces for Producing Copies of Type Writing, J. T. and F. W. Underwood, London.
10,782. Bustles, M. Rosenstock, London.
10,783. Folding or Pocket Camera, E. M. and G. H. Knight, Halifax.
10,784. Laying Wood Pavement, E. Bull, Halifax.
10,785. Lock Nut, T. Humpage and E. Shaw, Bristol.
10,786. Venetian Blinds, R. G. Hammond, Ipswich.
10,787 Coast and Harbour Defence, R. Scott, Newcastle-on-Tyne.
10,788. Portland Cement, A. Smith and J. Roberton, Glasgow.
10,789. Hot Banks for Iron and Steel Works, C While, Darlington.
10,790. Hydro-carbon Vapour or Gas Engines, J. Magee, Glasgow.
10,791. Valve for Gas Burners, W. Lyon, Sheffield.
10,792. Ash Pan for Fireplaces, C. Forrest and A. Sym, London.
10,793. Carding Engines, E. Chadwick.—(*T. Owen, India.*)
10,794. Sewing Machine, J. Davies, London.
10,795. Harmoniums, &c., H. Smith, London.
10,796. Obtaining and Applying Power, J. B. Prohias, London.
10,797. Handles to Milk Cans, &c., F. H. Freeth and S. J. Pocock, London.
10,798. Sulphuric Acid, H. J. P. Sprengel, London.
10,799. Shuttlecocks, G. P. Firth, Wakefield.
10,800. Carbon Machines, J. T Lister, London.
10,801. Cross-heads and Motion Blocks for Steam and other Engines, R. Edwards, London.
10,802. Bottles for containing Aerated, &c., Liquids, H. Barrett, London.
10,803. Stoppers for Bottles containing Aerated Liquids, H. Barrett, London.
10,804. Matches, C. R. E. Bell, London.
10,805. Cable Railways and Cable Car Gripping Mechanism, J. J. Endres, London.
10,806. Drying Machine, J. H. Lorimer, London.
10,807. Tobacco Stripping and Booking Machines, A. M Clark.—(*O Hammerstein, U.S.*)
10,808. Dressing, &c., Surfaces of Car Wheels, &c., J. G. Sibbald.—(*G. W. Miltimore, U S.*)
10,809. Automatic Weighing Apparatus, W. B. Avery.—(*C. C. Clawson, U.S.*)
10,810. Incandescent Electric Lamps, J. T. Armstrong, London.
10,811. Combined Pen, Pencil, and Memorandum, S. Steinhart and C. Q. Brugia, London.
10,812. Railway Cars, H. J. Haddan.—(*I. Hale and D. W. Richards, United States.*)
10,813. Operating the Breaking and Gripping Devices for Cable Railway Cars, J. J. Endres, London.
10,814. Paper Pulp Screens, C. Russell and P. H. Cragin, London.
10,815. Buttons, A. J. Boult.—(*E. Pringle, United States.*)
10,816. Thermostats, J. E. White, London.
10,817. Soles and Heels for Boots, &c., A. R. Burman, Liverpool.
10,818. Chains, A. J. Boult.—(*M. Jacker and J. B. Maas, United States.*)
10,819. Steam Boilers, &c., A. J. Boult.—(*T. Clifford, United States.*)
10,820. Water Motors and Meters, T. Melling and F. Butterfield, Liverpool.
10,821. Grips for Cable Railway Cars, J. J. Endres, London.
10,822. Iron and Steel, A. Brin, London.
10,823. Hardening Metal, J. Y. Johnson.—(*La Compagnie Anonyme des Forges de Chatillon et Commentry, France.*)
10,824. Electrical Batteries, J. T. Armstrong, London.
10,825. Cable Lifting Mechanism, J. J. Endres, London.
10,826. Thermometric Governors, P. M. Justice.—(*J. E. Holmes and H. C. Covert, United States.*)
10,827. Fountain Pens, W. R. Lake.—(*G. H. Sackett, United States.*)
10,828. Rendering Textile Fabrics, &c., Impermeable, W. R. Lake.—(*C. Orlay, Italy.*)
10,829. Scoria Paving Blocks, C. J. Dobbs, London.
10,830. Elastic Fabrics, O. Imray.—(*J. Reithoffers, Söhne, and L. Bollmann, Austria.*)
10,831. Producing Electric Light, H. de Clairmont and C. L. Field, London.
10,832. Letter-boxes, W. R. Lake.—(*T. Maynz, Germany.*)
10,833. Expressing Oil from Oleaginous Substances, N. Coste, London.
10,834. Bolt for Doors, &c., C. Groombridge and J. P Rickman, London.

25th August, 1886

10,835. Rotary Show Card, C. Mackey, Birmingham.
10,836. Screw Fasteners for Windows, J. Stow, Bradford.
10,837. Bottles, &c., J. R. Shearer, London.
10,838. Clogs, R. Nichols, Manchester.
10,839. Taps or Cocks, R. Barnes, Liverpool.
10,840. Fishing Lines F. J. Roberts, Manchester.
10,841. Advertising, D. Forbes, Glasgow.
10,842. Bleaching Fibrous Materials, J. Gibson and F. M. Gibson, Glasgow.
10,843. Fixing Rollers, &c., to Portmanteaux, &c., W. H. Jones and B. Jones, Wolverhampton.
10,844. Naves, N. Browne.—(*R. Einenkel, Saxony.*)
10,845. Patterns for Garments, C. S. Pusey, London.
10,846. Mess Tins, W. A. F. Blakeney, Glasgow.
10,847. Coupling for Railway Vehicles, R. C. Sayer, Newport, Mon.
10,848. Radiating Hood Cover for Soaking Pits, A. Harrison, Barrow-in-Furness.
10,849. Cotton Sliver Cans, W. Rhodes, Manchester.
10,850. Rapid Smoking of Fish and Provisions, E. Rundle, Royal Cornwall Infirmary.
10,851. Electric Alarm Clocks, J. W. Brown and F. T. Brown, Liverpool.
10,852. Moulding and Preparing Oil Seed, &c., J. Garrett, Halifax.
10,853. Stove or Fireplace with Ventilating Arrangement, A. J. Frey, London.
10,854. Slide Valve Mechanism, E. de Pass.—(*W. Hartmann, Germany.*)
10,855. Tobacco-pipes, A. G. Wass, London.
10,856. Water Tap or Ball Valve, W. Graty and J. W. Willis, Great Malvern.
10,857. Shuttles for Looms, H. Meissner, London.
10,858. Press for Compressing Yarn, &c., A. R. Donisthorpe, London.
10,859. Raising and Conveying Sewage, &c., T. Elworthy, St. Leonard's-on-Sea.
10,860. Bricks, &c., E. Nunn, London.
10,861. Raising the Covers of Gas Purifiers, &c., T. P. Hollick, London.

10,862. AUTOMATIC COMPENSATOR for SIGNAL WIRES, J. Hyde and F. Redman, London.
10,863. WOOD PRINTING MACHINES, J. Collis, London.
10,864. STOPPERS for BOTTLES, &c., H. Barrett, London.
10,865. INDICATORS or ANNUNCIATORS, C. H. G. Risch, London.
10,866. ENVELOPE MACHINES, P. A. Thomas, London.
10,867. MATERIAL for RECEPTACLES, PIPES, &c., used in the PETROLEUM TRADE, H. Thane, London.
10,868. OPERATING on ZINC ORE for PRODUCING CHLORINE, &c., J. Lea and H. R. Hammond, London.
10,869. INDICATING MECHANISM for WEIGHING, W. B. Avery, London.
10,870. SEWING MACHINE SHUTTLE WINDER, J. Gilmore and W. R. Clark, London.
10,871. VALVE GEAR of STEAM ENGINES, G. L. Lambert, London.
10,872. DISINTEGRATING, &c., MACHINERY, G. W. Elliott, Sheffield.
10,873. GUM, A. Rossi and C. Hellfrisch, London.
10,874. COMBINED STAY and FOOT for use with IRON FENCING, C. Bennet, London.
10,875. UNITING BARS of WOOD at RIGHT ANGLES, C. Bennett, London.
10,876. PAINTING BRUSHES, J. Pawsey, London.
10,877. REFLECTING LAMPS, &c., R. T. Strangman, London.
10,878. PLATES for PRODUCING STENCILS, E. de Zuccato, London.
10,879. RAILROAD GATES, J. H. Cluever and N. Thelen, London.
10,880. AMALGAMATING APPARATUS, T. D. Williams, London.
10,881. ROASTING COFFEE, &c., C. H. Bartlett, London.
10,882. ARTICULATORS for MAKING FALSE TEETH, A. Howarth, London.

26th August, 1886.

10,883. FILTERS, F. W. Brownlow, Manchester.
10,884. MELTING SNOW on RAILWAYS, C. J. Henderson, Hawick.
10,885. SPHERICAL STEAM ENGINES, W. E. Bland.—(*W. G. Pavey, India.*)
10,886. MACHINERY for FRAMING HATS, &c., J. Bevan, Manchester.
10,887. HINGES, H. H. Brand and W. H. Harper, Birmingham.
10,888. CASTERS, E. Moore, Birmingham.
10,889. DRAUGHT REGULATOR for RANGES, G. Adamson and J. T. Fenwick, Gateshead.
10,890. TRAMWAY RAILS, B. Temple, London.
10,891. ASBESTOS as a NON-CONDUCTOR of HEAT, W. Finlayson.—(*R. H. Martin, United States.*)
10,892. MEASURING the DISTANCES TRAVELLED by VEHICLES, A. Barker, Seacombe.
10,893. PREVENTING the PRIMING of BOILERS, &c., R. Williamson, Kingston-upon-Hull.
10,894. LAMPS for BURNING OIL, J. B. Fenby, Sutton Coldfield.
10,895. BREECH-LOADING SMALL ARMS, T. Woodward, Birmingham.
10,896. LIGHTING STREET LAMPS, J. J. Butcher, Newcastle-upon-Tyne.
10,897. BUFFERS of RAILWAY ROLLING STOCK, T. Oldham, Manchester.
10,898. MACHINERY for MAKING BUTTONS, J. M. Carlyle, Birmingham.
10,899. FILLIGRANING PAPER in the WEB, S. J. Timohowitsch, London.
10,900. FASTENING for SCARF, J. Ayres, London.
10,901. EDUCATIONAL CHECK SYSTEM, E. G. Peyton, London.
10,902. SECURING the MOUTHS of BAGS, D. A. B. Murray, jun.—(*T. Cleary, United States.*)
10,903. PRESERVING MILK, P. Jensen.—(*K. G. Dahl, Norway.*)
10,904. LAWN TENNIS BATS, F. H. Ayres, London.
10,905. COMBINED PLAYING-CARD HOLDER and WHIST MARKER, G. F. Lütticke, London.
10,906. COVERS for BOOKS, &c., W. G. Stoneham, London.
10,907. STIFFENERS of STAYS, R. Goff, London.
10,908. REVOLVING HEEL, W. Muirhead, London.
10,909. CASTORS for FURNITURE, J. Garvey, London.
10 910. OBTAINING ANTHRACENE, C. L. Remy and C. A. Erhart, London.
10,911. EVAPORATING the JUICE of BEETROOT, P. Labérie, London.
10,912. APPLYING ELECTRICITY to the HUMAN BODY, S. Pitt.—(*H. and W. P. Fairbanks, United States.*)
10,913. COOKING STOVE, P. Lapierre, London.
10,914. BORING APPARATUS, H. J. Haddan.—(*A. Fauck and E. Hasenoerl, Austria.*)
10,915. PARQUETRY, H. J. Haddan.—(*C. Gärtner, Germany.*)
10,916. PNEUMATIC ACTIONS in ORGANS, G. Adams and F. Marshall, London.
10,917. ASTRAGALS for ROOFS, D. Brown, London.
10,918. PURSE, J. E. Dowley, London.
10.919. CHIMNEY TOPS, &c., T. D. Bayliff, Liverpool.
10,920. BOLTS for FASTENING DOORS, F. Henson, London.
10,921. RAISING BEER, T. Sellars, T. Lockerbie, and C. Simpson, London.
10,922. LUBRICATORS for STEAM ENGINES, J. Smith and J. Annal, London.
10,923. REVOLVING CHAIRS, J. G. Dunlop, London.
10,924. TRANSFER of LOADS across STREAMS, C. H. Allworth, London.
10,925. IGNITING FIRES, &c., R. G. Bothamley, London.
10,926. APPLICATION of VOLTA INDUCTORS, C. D. Abel.—(—— *Siemens and* —— *Halke, Germany.*)

27th August, 1886.

10,927. ADMINISTRATION of MEDICAL ELECTRICITY, T. B. Grant, London.
10,928. TRAP TWISTING FRAMES, T. E. Smith and J. Ogden, Bradford.
10,929. FOOTBALLS, W. S. Bellerby, Bradford.
10,930. TABLE LEAF BRACKET, T. Osborne, Barrow-in-Furness.
10,931. ADVERTISING TABLET, S. H. Crocker, London.
10,932. THREAD GUIDES and MOUNTINGS, S. Tweedale, Halifax.
10,933. BLEACHING, &c., FIBROUS MATERIALS, E. and G. E. Sutcliffe, Halifax.
10,934. BOXES and BOX-MAKING APPARATUS, A. Burgon, Manchester.
10,935. VALVE MECHANISM, J. H. Dickson and H. W. Schwaben, Glasgow.
10,936. CORE BARS, C G. and J. E. Jordan and F. Herbert, Newport, Mon.
10,937. CASTORS, E. Moore, Birmingham.
10,938. APPLICATION of LEAD to PIANOFORTE ACTIONS, A. Hanson, Huddersfield.
10,939. LITHOGRAPHIC ROLLERS, J. I. Hemmingway and B. Barker, Sheffield.
10,940. DATE RACK, F. Sewill and J. Bélicard, jun., Manchester.
10,941. TOYS, G. Fischer, Berlin.
10,942. SAFETY COUPLING for VEHICLES, J. Aylward, Coventry.
10,943. STANDS for TABLES, &c., E. H. Hodson, Birmingham.
10,944. SCREWS and SCREW-DRIVERS, J. K. Starley, London.
10,945. VENTILATING HATS, S. Wilde, Hyde.
10,946. LIFEBUOY, F. J. and O. J. H. Davis, Plymouth.
10,947. RAISING, &c., WINDOW BLINDS, &c., J. Robertshaw, Manchester.
10,948 SHEEP-SHEARS, D. Ward and P. Ashberry, Sheffield.
10,949. FORCE DRAUGHT APPARATUS, J. W. Holden, London.
10,950. VALVES or TAPS, S. Bennett, London.
10,951. BOOTS, J. and G. Garrow, London.
10,952. BRANDING IRONS, M. H. Dement.—(*C. H. Hanson and E. C. Band, U.S.*)
10,953. MEAT SAFE, F. Plaister, London.
10,954. STAY for WINDOWS and DOORS, W. E. Copping, Anerley.
10.955. SODIUM BICARBONATE, J. I. Watts and W. A. Richards, Liverpool.
10,956. INDICATING, &c., TEMPERATURE, J. Murray, Glasgow.
10,957. PRODUCTION of BENZOL, ANTHRACENE, NAPHTHALINE, &c., from NAPHTHA, &c., A. Nikiforoff, London.
10,958. PRESERVATION of MEAT, H. J. Haddan.—(*S. Heumann and E. Heimann, Austria.*)
10,959. BUCKLE, S. J. Scovill, London.
10,960. MATERIAL for REMOVAL of OLD PAINT, M. Benedictus, London.
10,961. FURNACES for STEAM BOILERS, &c., W. C. Thayer, London.
10,962. ASBESTOS COMPOSITION, W. H. Irwin, Canada.
10,963. BOLTING MILLS, H. H. Lake —(*A. Heine, U.S.*)
10.964. FIRE-ARMS, H. H. Lake.—(*A. R. J. von Wehrstedt, Austria.*)
10,965. HAMMERS and other TOOLS, C. J. Grellner, London.
10,966. THROWING BELT-DRIVEN MACHINERY into and out of ACTION, J. A. A. Buchholz, London.
10,967. HOLDFAST for BLINDS, E. A. Showell, C. Showell, and E. Showell, jun., Birmingham.
10,968. DISINFECTING ANIMAL and other OILS, &c., A. Brin and L. Q. Brin, London.
10.969. HEATING STEAM BOILERS, &c., A. Brin and L. Q. Brin, London.

28th August, 1886.

10,970. FILTERS for TEA-POTS, C. Phillips, Aston, near Birmingham.
10,971. STEAM GENERATORS, J. Rance and J. Liddell, Glasgow.
10,972. STRAW TRUSSERS, J. Hornsby, J. Innocent, and C. James, Grantham.
10,973. LOCKNUT, E. Shaw and T. Humpage, Bristol.
10,974. ADHESIVE LABEL and GUM TAB, E. Byron, Birmingham.
10,975. THREAD WINDING MACHINES, J. Booth, London.
10,976. PNEUMATIC TOY, J. Chadwick, London.
10,977. GAS BRACKETS, &c., J. J. Royle, London.
10,978. RAPIDLY HEATING or COOLING LIQUIDS, J. J. Royle and J. Brown, London.
10,979. CARDBOARD BOXES, W. Dickinson, sen., W. Dickenson, jun., and L. Gardner, London.
10,980. FEED for the DELIVERY of CIRCULAR or other OBJECTS, W. Ackroyd, Blackburn.
10,981. ELECTRIC BELLS, W. Moseley, London.
10,982. ELECTRIC INDICATORS, W. Moseley, London.
10,983. COLLECTING WASTE HEAT from STEAM BOILERS, H. Montgomerie, Newcastle-on-Tyne.
10,984. FLYERS for SPINNING and ROVING SPINDLES, W. Young, Glasgow.
10,985. CHEMICAL FIRE EXTINGUISHING APPARATUS, P. Bowden and R. Hargraves, Bolton.
10 986. STOPPERING BOTTLES, G. W. Ellis, Huddersfield.
10,987. TREATING HIDES or SKINS, J. Townsend, Glasgow.
10,988. THREAD WINDING MACHINES, J. M. Cryer and J. T. Wibberley, Bolton.
10,989. ANNEALING WIRE, W. Walton, Manchester.
10,990. HEATING DOMESTIC TURKISH BATHS, T. Lawley, Birmingham.
10,991. AUTOMATIC REGISTERING TAP for WINES, &c., T. W. Newman, London.
10,992. KEY LABEL, J. Edmondson, Dublin.
10,993. CORKS or STOPPERS for BOTTLES, M. L. Macauley, Glasgow.
10,994. SLEEPING BERTHS or BEDS, J. T. Wylie, Glasgow.
10,995. UTILISATION of BLOOD from SLAUGHTER-HOUSES, H. P. Madsen, London.
10,996. DRUMS of ROTARY SCREENS, H. Shield and C. Cousins, London.
10,997. KEYS or WRENCHES for TURNING NUTS and BOLTS, B. J. B. Mills.—(*J. Thibaud, France.*)
10,998. BLEACHING COTTON, &c., B. J. B. Mills.—(*F. V. Serikoff and W. E. Smith, Russia.*)
10.999. GYROPULSATOR, S. S. Bromhead.—(*A. Legond, France.*)
11,000. PLACING DETONATING SIGNALS on RAILWAY LINES, G. S. Spencer, London.
11,001. GALVANIC BATTERY, W. H. Beck.—(*La Société Perreur-Lloyd et Etève, France.*)
11,002. SHEET METAL PIPES, W. H. Beck, London.
11,003. ELECTRICAL RAILWAYS, C. D. Abel.—(—— *Siemens and* —— *Halske, Germany.*)
11,004. OUTLET and INLET VALVES for LAVATORIES, &c., P. Winn, London.
11,005. SKIVING or SHARPENING LEATHER, C. Wagner, London.
11,006. RUBBER WATCH PROTECTORS, G. B. Gardner and W. Barker, London.
11,007. KEY RING, T. W. Henry, London.
11,008. BEVERAGES formed by DISSOLVING CHEMICAL MIXTURES, R. C. Scott, Liverpool.
11,009. NECK-TIES, G. Englander, London.
11,010. CONVERTING MECHANISM, A. J. Boult.—(*A. Blechschmid, Austria.*)
11,011. DISINFECTING POWDER, J. W. Knights and W. D. Gall, London.
11,012. GAS GOVERNORS, W. S. Lees and F. S. Lees, London.
11,013. MAKING BUTTON-HOLES, A. Helwig, London.
11,014. SEPARATING CREAM from MILK, H. H. Lake.—(*J. C. P. Sörensen, Denmark.*)

30th August, 1886.

11,015. PISTONS for STEAM ENGINES, A. MacLaine, Belfast.
11,016. HEARTH-RUGS, &c., J. Taylor, Manchester.
11,017. DRYING GRAIN, &c., W. J. Radford, Liverpool.
11,018. SILOS, T. Varley, Skipton-in-Craven.
11,019. MEASURING FABRIC, T. Murphie, Glasgow.
11,020. STOPPERING BOTTLES, &c., T. H. Duckworth and S. Wright, Manchester.
11,021. POLISHING METALLIC SURFACES, W. Horrox and A. Hobson, Sheffield.
11,022. FILLING OIL LAMPS and STOVES, C. T. Greenfield and A. J. Hutson, Brighton.
11,023. PAVING, &c., MATERIAL, F. Wicks, Glasgow.
11,024. PILOTS for STREET LOCOMOTIVES, W. Devoll, Erdington.
11,025. PREVENTING CORROSION, &c., of BOILERS, S. Hoyle, Accrington.
11,026. FIRE EXTINGUISHING COMPOSITIONS, E. A. Brydges, London.
11,027. ORNAMENTATION of WALLS, &c., J. Sutherland, London.
11,028. MAKING the LEGS of TOY HORSES move to represent WALKING or RUNNING, H. Tanner, Walthamstow.
11,029. VALVES for STEAM, &c., W. Wellbury, London.
11,030. SHIP'S BERTHS, D. Macallan, Liverpool.
11,031. JACQUARD APPARATUS, J. Hall and P. Pearson, London.
11,032. PRESSES for COPYING, &c., PURPOSES, H. Heatly, London.
11,033. MANUFACTURE of FIGURED CLOTH, D. Greenhalgh, London.
11,034. TREATING SKINS of OXEN to produce an imitation HOG, &c., LEATHER, E. Edwards.—(*H. Höbuss, Germany.*)
11,035. STRAW PLAIT MILLING by MACHINE, W. Bates and F. Smith, Luton.
11,036. HINGES, F. Northall, jun., Birmingham.
11,037. COMBINATION COPYING BOOKS and PRESSES, A. J. Boult.—(*E. L. Fargo, United States.*)
11,038. NECKS and STOPPERS of BOTTLES, F. W. Cleveland, London.
11.039. SAFETY of RIFLE RANGES, T. C. S. Brown, Nunhead.
11,040. NEW SECONDARY BATTERY, E. Andreoli, London.
11,041. OBSERVING from a DISTANCE INDICATIONS by THERMOMETERS, &c., P. Moennich, London.
11,042. WASHING MACHINERY, A. Bruckner, London.
11,043. MAKING WAX, &c., MATCHES to LIGHT PIPES, D. Lindo, London.
11,044. STATION BOXES for LIFE BUOYS, G. Aram, London.
11,045. METALLIC PIPES and FITTINGS, G. L. Lavender and H. P. Lavender, London.
11,046. PORTABLE MARQUEES, &c., W. R. Gibson, London.
11,047. LAMPS for BURNING MINERAL OILS, E. de Raet, London.
11,048. PURIFYING LIQUIDS, F. Candy, London.
11,049. TOOLS used in the MANUFACTURE of BOTTLES with SCREW STOPPERS, W. Macvay, R. Sykes, and H. Codd, London.
11,050. STEAM ENGINES, D. Joy, London.

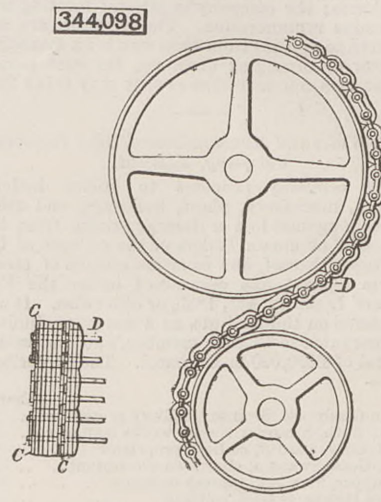
SELECTED AMERICAN PATENTS.

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

344,098. MACHINE BELTING, *Alfred J. Gasking, Enfield, County of Middlesex, England.—Filed April 15th*, 1886.

Claim—(1) A belt for transmitting power, consisting of a metallic frame, substantially as described, having transverse rods, in combination with pieces of leather or other frictional material arranged on said rods between the sides of said frame, and presenting the operative surface to the wheels, substantially as set forth. (2) The combination of the links, C, having overlapping ends, with the transverse rods D, which pass through said ends to form a flexible chain, having said links for its sides, and the pieces of leather which are arranged on said rods to present a frictional surface to the wheels, substantially as set forth.

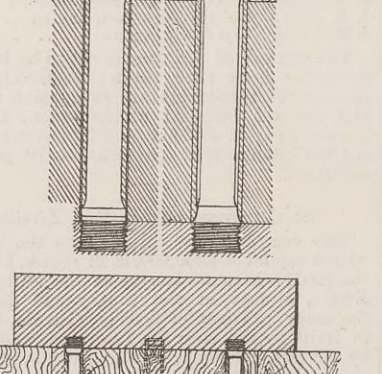
344,098



344 218. ATTACHING ARMOUR-PLATES TO VESSELS, *Edouard Tardy, Douvres, Calvados.—Filed March 4th*, 1886.

Claim.—(1) The combination of the armour-plate, the wall, an attaching bolt, a sleeve surrounding the same, and a packing ring at the end of the sleeve, substantially as described. (2) In combination with a wall and armour-plate, a bolt having the threaded end thickened and the shank reduced, and a sleeve surrounding said bolt, substantially as described. (3) In combination with the armour-plate and the protected walls, the bolts having reduced shanks of uniform diameter and serving to attach the armour-plate to said wall, substantially as described. (4) The combination, with the armour-plate and protected wall, of the bolt having a reduced shank and the sleeve surrounding the same substantially as described. (5) In combination, with the armour-plate and the wall, of the bolts passing through the wall and tapped into said armour-plate, the sleeves surrounding the bolts, the packing rings at the ends of said sleeves, and the cups, washers, and nuts at the inner ends of the bolts, substantially as described.

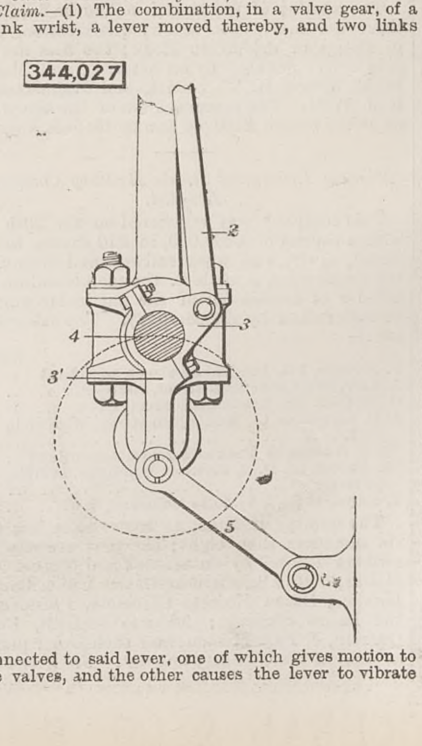
344,218



344,027. VALVE GEAR, *Charles H. Benton, Cleveland, Ohio.—Filed February 23rd*, 1886.

Claim.—(1) The combination, in a valve gear, of a crank wrist, a lever moved thereby, and two links connected to said lever, one of which gives motion to the valves, and the other causes the lever to vibrate relatively to the crank wrist, substantially as and for the purpose set forth. (2) The combination, in a valve gear, of a crank wrist, a bell-crank lever, 3 and 3^1, a link, 2, giving motion to the valves, and a link, 5, joined to the engine frame, substantially as and for the purpose set forth.

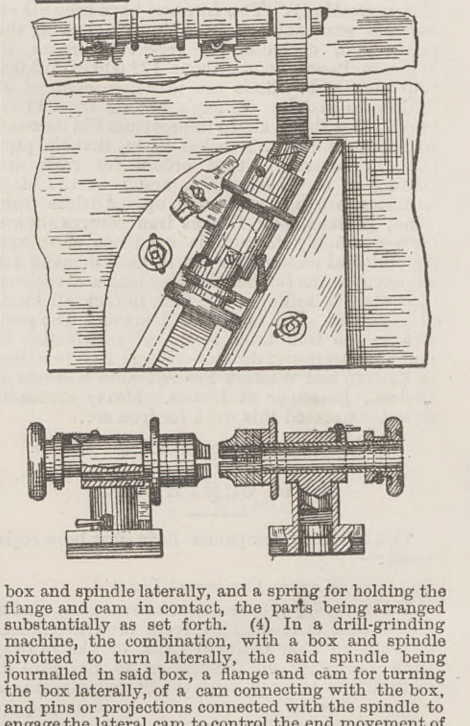
344,027



344,329. MACHINE FOR GRINDING TWIST DRILLS, *Sumner G. Ryder, Cleveland, Ohio.—Filed December 26th*, 1885.

Claim.—(1) In a drill-grinding machine, the combination, with means, substantially as described, for revolving the drill, of a cam and spring for moving the drill forward toward the emery wheel, and a cam and engaging flange for swinging the drill laterally in the direction away from the drill, the parts being arranged substantially as described. (2) In a drill-grinding machine, the combination, with a box pivotted to turn laterally, a spindle journalled in the box, said spindle having end play, of a flange connected with the spindle, and a cam for engaging the flange so as to turn the box and spindle laterally as the spindle is moved endwise, substantially as set forth. (3) In a drill-grinding machine, the combination, with a box and spindle pivotted to turn in a horizontal plane, said spindle journalled and having end play in the box, of a flange connected with the spindle, a cam to swing the box and spindle laterally, and a spring for holding the flange and cam in contact, the parts being arranged substantially as set forth. (4) In a drill-grinding machine, the combination, with a box and spindle pivotted to turn laterally, the said spindle being journalled in said box, a flange and cam for turning the box laterally, of a cam connecting with the box, and pins or projections connected with the spindle to engage the lateral cam to control the end movement of the spindle, substantially as set forth. (5) In a drill-grinding machine, the combination, with a box mounted on a depending arm or trunnion, a spindle journalled and having end play in the box, a flange and cam for turning the box laterally, of a cam and engaging pins for controlling the end movement of the spindle, and a spring for driving the spindle forward, the parts being arranged substantially as set forth.

344,329



344,502. JET CONDENSER, *L. Schutte, Philadelphia, Pa.—Filed March 6th*, 1886.

Claim.—(1) In a jet condensing apparatus, as a means of automatically supplying live steam to maintain the action during the cessation of exhaust steam, the combination, substantially as described, of a steam jet condenser and a live steam supply valve connected by operating appliances with the vacuum chamber of the condenser and controlled by variations in the vacuum or pressure therein. (2) In combination with a condenser of the type herein described, to be operated by exhaust or low-pressure steam, a valve to admit live steam to continue the action of the apparatus during the temporary failure of exhaust steam, and devices to open and close said live steam valve, connected with and controlled by the vacuum in the condenser, substantially as described and shown, whereby the live steam is automatically shut off during the continuance of the vacuum by the exhaust steam. (3) In combination with the combining tube, its encircling chamber, the water nozzle, and the live steam nozzle, the automatic valve S, controlled by fluid pressure through an auxiliary piston, and a pipe connecting the same with the interior of the condenser, as described. (4) In a condenser to be operated by exhaust or low-pressure steam, the combination of the combining tube with inlet openings, as described, its inclosing chamber, the water admission nozzle, the passage leading from the middle of the water nozzle to the atmosphere, and a valve for closing said passage. (5) In a jet condenser of the type herein shown, the water inlet nozzle, combined with the passage leading outward from an intermediate point in the length of said nozzle, and the dip pipe connected to said passage, to prevent the admission of air and the diffusion of steam. (6) In a steam jet apparatus, the combination of the inlet nozzle and the regulating ram or spindle having one end guided by said nozzle. (7) In combination with a jet condenser of the type herein described, an outwardly opening exhaust O to permit the free escape of the incoming steam when the condensing action ceases.

344,502