ADMIRALTY COEFFICIENTS.

By ROBERT MANSEL.

I HAVE made the following deductions from the very valuable data contained in the report of the paper on "The Speed Trials of Recent War Ships," by Mr. W. H. White, as published in THE ENGINEER of 16th April:—Although these may seem somewhat counter to those of Mr. White, I assume no question can arise paramount in importance to the attaining of correct views on this difficult and important subject, which I again approach by the old road of the Admiralty coefficients, quantities of which, many years ago, I made a special study, and for the sake of the amount of truth which they involved, and as being a means of attaining a higher level, I have fiercely defended against hostile criticism, in most cases advanced through mistaken notions on first principles, and in others from a misconception of the nature and scope of the method—errors from which the speculations of some eminent authorities have not been free.

That I was cognisant of the usually stated objections to these quantities will, I think, be obvious from the following reference to a letter of mine published in the *Artizan* so far back as September, 1857, where I will be found to have advanced the following statements:—"The Admiralty coefficients in this way are made to represent the comparative combined scientific efficiency of the vessel, her propeller, and engine. In the hands of a constructor of moderate experience and intelligence, these equations afford an exceedingly simple determination of the relation that will exist between the power and speed in a proposed vessel. He is little likely to apply the same coefficients indiscriminately to every description of vessel, or feel astonished at discovering, on deducing by actual experiment the values of these coefficients; not only that they varied in different vessels, but in the same vessel they also varied with the speed and draught. If he felt this variation to be an intolerable grievance—and if he had the requisite patience and ability—his obvious course would be a return to the ignored or misrepresented elements of his formula, and then combine them with absolute constants." Mr. White's data yield some very pertinent illustrations to all this, starting with the assumption that a steam vessel, although a very complicated machine, is still subject to the same laws as simpler machines. Suppose a machine doing the same kind of work at different speeds, it may be during successive trials under altered conditions, or equally different machines of a similar type doing like work. Obviously, in each case, the work done, when divided by the power doing it, would yield a numerical ratio which ought to be a fair measure of the comparative efficiency in the various cases. This is the theory of the Admiralty coefficients, which further assume the work done as proportional to the square of a lineal dimension by the cube of the speed; or, as applied in practice, proportional to the product of the (immerged mid area) × speed ^{3}, alternatively, by the (displacement) $^{\frac{2}{3}}$ × speed ^{3}; or, again, by the (immersed surface) × speed ^{3}. The general statement embracing all three cases; and, as far as they go, it is a matter of indifference which is adopted; the one set of values will differ from the others by a constant ratio. The ratios of any one set of them to the corresponding powers present singularly anomalous results; and, for the same vessel at different speeds, yield coefficients with as great differences as those resulting from the most varied dimensions and form. For example, Mr. White's data, for the celebrated vessel Warrior at speeds 14·356, 12·174, and 11·040 knots, the corresponding Admiralty displacement coefficients are given as 231·5, 269·3, and 289 6 respectively. Do these variations in value really represent true variations in comparative efficiency at those speeds? I believe it can be shown perfectly clearly that they do not. What they exhibit is the variations due to a false law of the resistance which has been assumed in estimating the work done, and we have only to put the formula in even an approximately correct shape, to reduce these large variations to smaller, lying within the limits of unavoidable errors of observation. Large variations doubtless are often detected, but it seems to me are then referable to changes in the conditions and circumstances of trial; since it may be shown, in the successive trials of the same vessel, we have alterations in the circumstances which are not recognised in our theories and formulas, and which are only made evident to us through their resultant effect upon the trial results. The problem is, to fix ideas, taking the Admiralty displacement coefficient $C = \frac{D^{\frac{2}{3}} V^3}{E}$. In successive trials of the same vessel, at different speeds, can we determine a factor which will render this quantity C constant for all the speeds? I have shown, if the conditions remain the same, a factor of the form* $\frac{\log^{-1} a V}{V^2}$ will do so; in which case we obviously have $\frac{C \log.^{-1} a V}{V^2} = \frac{D^{\frac{2}{3}} V \log.^{-1} a V}{E}$ $= c$, suppose an absolute constant instead of C a very variable one. Let us test this, the matter being practically wrought out as follows:—Take the logarithms of the Admiralty coefficients for each speed, and the residues, after having subtracted from each twice the logarithm of its speed, will possess this curious property: a small fraction of the speed added to each residue will render it practically constant, and this will be the logarithm of the quantity c, the absolute constant. As a formula this is expressed by

$$\log. C - 2 \log. V + a V = \log c \quad . \quad . \quad (1)$$

Example, in the Warrior the various trial speeds are as follows, the value of a = ·098:—

Warrior a = ·098.

Trial speeds V	=	14·356	12·174	11·040
Value ·098 V	=	1·4069	1·1931	1·0819
Add log. C	=	2·3646	2·4302	2·4618
Subtract 2 log. V	=	2·3144	2·1706	2·0860
Log. c	=	1·4571	1·4527	1·4577
∴ c	=	28·65	28·35	28·69

Average c=28·6 an absolute constant.

To compare with C=231·5 .. .. 269 3 .. .. 289·6

The Admiralty displacement coefficients.

In like manner there is little difficulty in determining for the other vessels, of which Mr. White has published data, the values of this constant coefficient, to which I will add the values for four other war-ship trials, and also of two merchant vessels, which have been published in one or more of my papers; also, to show that these are not imaginary or random figures, I will add the numerical process by which they have been obtained, with note of some necessary considerations in such inquiries. I shall take the shorter examples first in order.

TABLE I.

H.M. war vessels.	Value a.	Value c.
Warrior	·098	28·6
Howe	·0873	21·4
Collingwood	·081	18·0
Hercules	·093	16·95
Imperieuse	·081	16·3
Bellerophon	·090	15·5
Edinburgh	·071	12·8
Shah (5) to (8)	·0792	14·5
Iris (14) to (17)	·0750	13·4
Heroine	·085	14·78
Fire Brand	·138	33·3
Merchant vessels:—		
Merkara	·0735	14·78
Charles Quint	·0842	25 0

Hercules a = ·093

Trial speeds V	=	14·69	12 12
Values a V	=	1·3663	1·1274
Log. C − 2 log. V	=	−1·8619	·1025
Sum or log. c	=	1·2282	1·2299
∴ c	=	16·91	16·98

Average 16·95

Imperieuse a = ·081

Trial speeds V	=	17·213	10 096
Values a V	=	1·3943	·8178
Log. C − 2 log. V	=	−1·8165	·3937
Sum or log. c	=	1·2108	1·2135
∴ c	=	16·25	16·35

Average 16·3

Fire Brand a = ·138

Trial speeds V	=	10·17	9·20	7·98
Values a V	=	1·4034	1·2756	1·1012
Log. C − 2 log. V	=	·1164	·2520	·4192
Sum or log. c	=	1·5198	1·5276	1·5204
∴ c	=	33·1	33·7	33·2

Average 33·3

Collingwood a = ·081

Trial speeds V	=	16 844	16·602	16 051	12·621	10·236	7·988
Values a V	=	1·3644	1·3448	1·3001	1·0223	·8291	·6470
Log. C − 2 log. V	=	−1·8506	−1·9061	−1·9667	·2301	·4184	·6098
Sum or log. c	=	1·2250	1·2509	1·2668	1·2524	1·2475	1·2568
∴ c	=	14·79	17·82	18·48	17·88	17·68	18·06

* Omitting first, average 18 0

Howe a = ·0873

Trial speeds V	=	16·923	15·873	13·386	10·25	8·938
Values a V	=	1·4771	1·3854	1·1689	·8948	·7805
Log. C − 2 log. V	=	−1·8204	−1·9414	·1696	·4341	·5466
Sum or log. c	=	1·2975	1·3268	1·3385	1·3289	1·3271
∴ c	=	19·83	21·22	21·80	21·33	21·23

Omitting first, average 21·4

Edinburgh a = ·071.

Trial speeds V	=	15·991	11·961	9·849	8·097
Values a V	=	1·1353	·8492	·6994	·5751
Value log. C − 2 log. V	=	− 1·9671	·2642	·4064	·5882
Sum or log. c	=	1·1024	1·1134	1·1458	1·1633
∴ c	=	12·66	12·99	12·76	14·58

Omitting fourth, average 12·8

Heroine a = ·085.

Trial speeds V	=	13·12	12·43	11·47	9·16
Values a V	=	1·1152	1·0566	·9750	·7786
Value log. C − 2 log. V	=	·0554	·1041	·1990	·3930
Sum or log. c	=	1·1706	1·1607	1·1740	1·1716
∴ c	=	14·81	14·48	14·93	14·84

Average 14·78

In reference to the foregoing calculations, a few explanations are necessary. In the Collingwood calculation, the average value of C is given with the highest speed result rejected; since, Mr. White has given the explanation that this last trial was made with a 17ft. 6in. pitch screw, and all the others with one of 18ft. 10¾in. pitch; by this change of condition the mean value 18·0 is brought down to 16 79; or it may be, as in the Howe, where the highest speed value is also rejected, it simply illustrates the effect of the engine racing and expending power in churning water instead of propelling the vessel. It is not difficult to deduce the normal law of the revolutions during the lower speeds, and thence arrive at the proportion of the power thus wasted; but not to diverge into side issues, I only take the lower speeds which afford sufficient evidence of the existence of a normal value, which is only influenced to an extent that reasonably falls within the limits of mere errors of observation.

In the Edinburgh I have rejected the lower speed for two reasons; the difference which this exhibits may arise from unbalanced residues of tidal and wind drift, which, especially at low speeds, are never properly eliminated by the usual method of averaging observations; or, again, it may be due to a change in the circumstances which I have remarked are only known to us by their resultant effect upon the trial data. That there are such changes can be detected amongst the low speed trials of almost every vessel; and in torpedo boats, where a greater range of speed is attainable, a second set of changes can be detected amongst the highest speeds. I have drawn attention to the fact; the late Mr. John Scott Russell noticed this phenomenon in his canal traction experiments fully forty years ago, and about that period was commented on by the eminent author, M. Poncelet, in his "Mecanique Industrielles." I may also notice in the second trial of the Heroine, by several independent lines of investigation, it can be shown that the speed, with great probability, has been slightly understated; instead of 12·43 knots, as published in the Admiralty trials, it ought to be 12·51, a value which would have given c, practically, the same value as in all the other trials. I shall not occupy your columns by giving the detailed calculation for the other vessels I have quoted. They will be found published in one of the lectures in connection with the Naval Exhibition held in Glasgow in the winter of 1880.

I now proceed to consider a most important point in the application of these deduced constants to the measure of the comparative efficiency of vessels. We must never forget that they only directly apply when the small quantity a has the same value in the contrasted vessels, as, for example, in the Collingwood and Imperieuse, where the value is the same, viz., ·081; in other vessels it is seen to range from ·071 in the Edinburgh to ·138 in the Firebrand, and before comparing the deduced coefficients c, we require to modify them to the values they would have presented if the quantity a had been of the same value in all; further, that the several vessels be all driven at one uniform standard speed, in which case it ought to be the highest speed, which, under normal circumstances, the whole of them are capable of attaining. For example, in the following Table No. II., the first six vessels are capable of attaining 16 knots, the five succeeding are equally capable of 14 knots, and the last, the Firebrand, is only good for 10 knots. We also find the least value of a is that of the Edinburgh, which is therefore taken as the standard, and we form a column of the differences between this and the other values of a, as in Table No. II. In the next column is tabulated the logarithms of the deduced values of the absolute constant c, from which falls to be deducted the product of the assumed standard speeds by the values in the column of differences of a; the residues are the logarithmic values of the true comparative efficiencies of the various vessels at the assumed respective standard speeds. We therefore apply the 16 knot products to the first six vessels, then the 14 knot products to the first six and succeeding five vessels, and, finally, the values of the 10 knot column to the whole number; the resulting numbers, as given in the columns with the distinguishing suffixes c_{16}, c_{14}, and c_{10} are the comparative efficiencies at the respective speeds as tested by a very approximately true dynamic standard of the work done in each case!

TABLE NO. II.

Name of vessel	Value of a.	Values a − ·071.	Values Log. c.	Log. c −16 (a − ·071)	Log. c −14 (a − ·071)	Log. c −10 (a − ·071)	Values of comparative efficiency.		
							c_{16}	c_{14}	c_{10}
Imperieuse	·0810	·0100	1·2122	1·0522	1·0722	1·1122	11·28	11·81	12·95
Collingwood	·0810	·0100	1·2553	1·0953	1·1153	1·1553	12·45	13·04	14·30
Howe	·0873	·0163	1·3304	1·0696	1·1022	1·1674	11·74	12·65	14·70
Edinburgh	·0710	·0000	1·1072	1·1072	1·1072	1·1072	12·80	12·80	12·80
Shah	·0792	·0082	1·1614	1·0302	1·0466	1·0794	10·72	11·13	12·01
Iris	·0750	·0040	1·1271	1·0631	1·0711	1·0871	11·57	11·78	12·22
Hercules	·093	·0220	1·2292	—	·9212	1·0092	—	8·34	10·21
Warrior	·098	·0270	1·4564	—	1·0784	1·1864	—	11·98	15·36
Merkara	·0735	·0025	1·1697	—	1·0347	1·1447	—	10·83	13·95
Charles Quint	·0842	·0132	1·3979	—	1·2131	1·2659	—	16·33	18·45
Bellerophon	·0900	·0190	1·1903	—	·9243	1·0003	—	8·40	10·01
Firebrand	·1380	·0670	1·5224	—	—	·8524	—	—	7·12

In the foregoing, my object has been to deduce constant from varying quantities, and it may furnish a corroborating proof of the validity of my procedure, to take the converse problem; and from my derived constant quantities, show how the variable ones can be deduced from them. For example, take H.M.S. Shah, for which the values of a and c have been given as ·0792 and 14·5 respectively; by equation (1) we have log. C = log. c + 2 log. V − a V, from which let us calculate the values of C, the Admiralty displacement coefficients for the various trial speeds of that vessel, as given by the Admiralty return.

Trial speeds V	=	16·45	12·13	8 01	5·32
Subtract value ·0792 V	=	1·3029	·9607	·6344	·4214
Add log. c	=	1·1614	1·1614	1·1614	1·1614
Add 2 log. V	=	2·4324	2·1676	1·8072	1·4518
Value log. C	=	2·2909	2·3683	2·3342	2·1918
∴ C	=	195·4	233·5	215·9	155·5
Trial data values	=	194·9	233·1	218·0	155·3
Differences		+·5	+·4	−2·1	+ 2

The differences are obviously very small, and a very slight alteration on the values of a and c would make these vanish in the case of three of them, and leave only an error of 1 per cent. on the 8-knot trial. Now there is no sufficient reason for an obvious reign of law, in three out of four cases, to be discredited by the occurrence of a slight discrepancy in the fourth; but as the Leibnitzian argument is considered somewhat of the nature of "ladies' logic," we shall put it in the sterner light of Hume's ditto, and assert that it is far more likely some error of calculation or observation has been committed in the data of this trial, rather than the alternative, that this trial contradicts the concurrent testimony of the other three.

The nature and meaning of the small quantity a may be briefly adverted to. In analytical mechanics it would be defined as the differential coefficient, in respect of the speed, of the logarithm of the resistance, or, as a formula, $a = \frac{d \log. R}{d V}$. The following simple proof may suffice:—Let E be the gross indicated power expended in driving a vessel whose resistance is R at the speed V knots. By the fundamental principles of mechanics, we know log. E = log. R + log. V + log. const., which, being differentiated, yields

$$\frac{dE}{E} = \frac{dR}{R} + \frac{dV}{V} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Let us now assume the relation, $E = b V \log.^{-1} a V$, where b is a constant quantity; then, by taking logarithms,

* The expression $\log.^{-1} a V$ is mathematically equivalent to 10^{aV}, that is to say, the number, whose common logarithm is the value of aV. The meaning of the V^2 in the denominator is to replace the false assumption of the value of the resistance, as involved in the Admiralty coefficients by the foregoing quantity, $\log.^{-1} a V$.—R. M.

log. E = log. b + log. V + a V, which, being differentiated, gives

$$\frac{d\,E}{E} = \frac{d\,V}{V} + a\,d\,V. \quad . \quad . \quad . \quad . \quad (3)$$

But "things equal to the same are equal to one another," and comparing the second members of (2) and (3), obviously $\frac{d\,R}{R} = a\,d\,V$, and as the first member of this is d log. R, it follows $a = \frac{d \log. R}{d\,V}$.

Also E = b V log.$^{-1}$ a V is the correct form for the Admiralty coefficient formula. E denoting the power for the speed V, and b a quantity involving the dimensions element, and the usual coefficient of the Admiralty formula, whether this be taken as $\frac{M\,V^3}{E}$, or $\frac{D^{\frac{2}{3}}\,V^3}{E}$, or, $\frac{\text{immersed surface } V^3}{E}$

The practical mode of determining the value of a is very simple. First, from the logarithms of the coefficients of either of the above formulas, subtract twice the logarithm of the corresponding speed. Secondly, laying off the speeds in common numbers by a scale along a line taken as axis of abscissas, at each trial speed point, set up ordinates of the residues determined by the first step; they will be found to range in a straight line inclined to the axis, and the natural tangent of this angle is the value of the quantity a, and, by the principles of co-ordinate geometry, on taking any two points in this line the difference of the ordinates divided by the distance between them, along the axis, that is to say by the difference of the respective speeds, gives the quantity a as their quotient. There are some few minor matters, to which, had my letter not run to such a length, I would have alluded. I shall not notice them at present. ROBERT MANSEL.

White Inch, Glasgow, April 24th.

THE EDINBURGH INTERNATIONAL EXHIBITION.

No. II.

SINCE visiting the Exhibition for the first time, three days previous to the opening, and reporting generally in last week's issue on a portion of what was then to be seen, we have visited it under more advantageous circumstances, *i.e.*, with the buildings open to the public, the whole display in comparatively perfect order, and a catalogue of the exhibits available, the machinery section in a thoroughly completed condition, and the lighting of the buildings and grounds by electricity in a state of great perfection. The success of the latter feature, indeed, at so early a stage in the history of the Exhibition is a noteworthy circumstance, and great credit is due to the various contractors carrying out the work, no less than to Mr. W. A. Bryson, the electrician, who has supervised this important department. Further reference to this feature, however, must be reserved until we have completed our survey of the machinery in motion and other sections of most interest, as explained and entered upon in our opening notice.

Marine engineering and shipbuilding, as already stated, are but indifferently represented, considering the nearness of Edinburgh to the principal shipbuilding centre of the kingdom. The maritime exhibition at Liverpool to some extent accounts for this shortcoming, but the principal reasons must be sought for in the severe depression under which the industries rest, in the inadaptability of such ponderous objects as engines and ships to the purposes of exhibition at a distance, and perhaps in some degree to half-heartedness in the Edinburgh undertaking on the part of Glasgow and Clyde firms. It was only by much painstaking advocacy and adroit management that Glasgow and other Clydeside towns were won over to assist in furthering the project of holding an international exhibition in Edinburgh. The feeling that Glasgow—the "commercial capital"—was better suited and as well entitled to be the site for such an exhibition was both keen and widespread. This feeling was intensified, indeed, through the knowledge that an exhibition on a large scale, and thoroughly worthy of the vast industrial and commercial importance of Glasgow and the Clyde valley, had been a project privately canvassed and even openly discussed for some years. So far as shipbuilding and marine engineering are concerned, then, the present Exhibition leaves to Glasgow its own special field uncovered, if not untouched.

Small scale models are both handy and effective mediums for representing the industry of shipbuilding; consequently the number of these ships in miniature on the walls and floors of the Edinburgh buildings is considerable. Most of the Clyde firms send a selection of their finest vessels. Apart from the interest attaching to many of the models as representing actual, and, it may be, notable, steamships, not a few of them are most admirable as works of art. They are arranged in glass cases and upon the walls of the grand hall. Messrs. J. and G. Thomson, of Clydebank, in addition to well-finished models of the Servia, the America, and others of their notable productions, exhibit a working model of the engines fitted on board the vessel last named, the workmanship being in all respects admirable. Messrs. Caird and Co., of Greenock, in a tasteful stand exhibit, amongst other models, one of the Orinoco—a steel vessel of 5000 tons displacement they are at present building for the Royal Mail Company—and one of the troopships they have on hand for the Indian Government. Messrs. the Fairfield Shipbuilding and Engineering Company, Govan, make a most interesting show, the variety of their exhibits being such as to include models of the notable transatlantic "greyhound," Alaska, and of that ill-fated oddity in naval architecture, the Russian Imperial yacht Livadia; also of the noted China tea clipper Stirling Castle; the Red Cross Society's ambulance stern-wheel steamer Red Cross, built for ambulance service with the Nile Expedition; and the screw steam fishing vessels Cormorant, Heron, Pelican, and Albatross, the first-named was built so far back as 1866, and was about the first adaptation of a steam vessel to fishing service. The same exhibitors show a full model, finished in the same superb style as the Alaska, of the new North German Lloyd's steamship Aller, the first of three similar vessels now building in Fairfield for this enterprising company. In connection with the same vessel the exhibitors are about to place in their stand a working model of the engines to be fitted on board, being of the triple expansion type, 7000 indicated horse-power, and fitted with the Bryce-Douglas patent valve gear. It is noteworthy that the engines thus represented on a small scale are the largest triple expansion engines yet afloat, and the first that have been fitted into any of the New York passenger lines. Messrs. R. Napier and Sons, of Govan, include in their collection of Government and mercantile vessels a model of the steel armour-belted cruiser Australia now under construction, and the fast steel cruiser Leander, built in 1883 for the British Admiralty. Messrs. Henderson Brothers, of the Anchor Line, show a model of the well-known Transatlantic steamship Furnessia. Messrs. Denny Brothers, of Dumbarton, exhibit, amongst a host of their other productions, a model of the Peninsular and Oriental steamship Clyde, and one of the Doo Woon, a typical light draught many-decked Indian river paddle steamer, for which this firm have justly a high reputation. Messrs. Wm. Simons and Co., of Renfrew, show models of their patent hopper dredgers with traversing bucket ladder; and the Clyde Trustees put on view a large and varied collection of photos, &c., illustrating the dock and harbour works presently in progress.

In marine engineering the machinery section contains almost nothing that is of an elaborate or novel description. A few firms exhibit yacht and launch engines, but no marine engines of large dimensions, such as found a place in the maritime exhibition at Tynemouth three years ago, and at the recent Antwerp Exhibition, have been sent. Mr. W. B. Thomson, of Glasgow and Dundee, shows in motion a set of triple compound engines of 20-horse power, driving a portion of shafting and propeller. Elsewhere the same exhibitor shows models of some of his vessels, and of patent windlass, hand steering gear, &c.. Messrs. Paul and Co., of Dumbarton, make an important show of their launch engines and boilers, the former having a noteworthy feature in the patent valve motion invented by the firm. One item is a light draught screw steel steam launch for river service, 27ft. long, fitted complete with boiler and engine, the latter being single and non-condensing, 5in. cylinder and 5in. stroke, and to run at 500 revolutions per minute; the boiler is a horizontal tubular, working at a pressure of 100 lb. Messrs. Hawthorn and Co., of Leith, exhibit in motion compound surface-condensing engines, with 9in. and 12in. cylinders by 12in. stroke, and having Chapman's patent air and circulating pump. The same firm exhibit Cormack's patent single slide valve compound engine. Messrs. Kincaid and Co., of Greenock, John Cran and Co., of Leith, and Sproul and Co., of Greenock, also exhibit steam launch machinery, the latter likewise showing a new design for steam steering engines. Messrs. Hastie and Co., of Greenock, exhibit a patent hydraulic engine, which is said to automatically regulate the consumption of water in direct proportion to the work done. Several well-known firms exhibit steam pumps, and of course there is quite a number of exhibitors of the smaller items of machinery outfit, such as safety valves, injectors, governors, piston rings, springs, and packing; feed regulators, feed heaters, &c.; but, so far as our survey served us, nothing of a strikingly novel description is brought forward. Mr. Samuel Smillie, of Lancefield-street, Glasgow, shows a new patent instantaneous feed heater, and, in operation, new fresh water condensers, which appear successfully to combine efficiency with extreme simplicity and accessibility of parts. Messrs. McKaig and Still, of Water-street, Liverpool, exhibit the model of a marine boiler, illustrating their patent cylindrical combustion chambers. Non-conducting compositions for boilers, &c., and asbestos in its varied adaptations to engineering, are alike prominently shown in this and other sections. In the court set apart for what is termed "sea industries," Messrs. Tagg and Son, of East Molesey, London, exhibit specimen portions of ships' decks, &c., with the seams served and payed on a new principle patented by them; and in the same section the Berthon Boat Company shows its excellent boats, and Messrs. Copemaur and Pinhey their life-saving specialties.

In the grounds outside the machinery-in-motion section, the Steel Company of Scotland exhibits a large cast steel sternpost and ram stem for a Government vessel, as well as other steel castings. Adjacent to this stand, Messrs. Jessop and Co., of Sheffield, have erected, with other exhibits, a full-sized model of crucible cast steel stern frame for a twin-screw steamer, cast with brackets for propeller, all in one piece, and a solid cast steel rudder with movable head-piece. Alongside, Messrs. Laidlaw and Sons show a great variety of their cast steel pipes ranging from 36in. to ⅝in. diameter. In the central avenue the Steel Company of Scotland is represented by a stand of the "trophy" order, consisting of specimens of bar and angle steel and cast steel pillars, erected in the form of a temple or archway surmounted by a huge boiler flanged plate; the whole set off with lighter material, bent and twisted into a variety of fantastic shapes. Elsewhere the Barrow Hematite Steel Company shows, in glass cases, examples of its manufacture.

Four of the most imposing exhibits in the building are locomotive engines and tenders complete, erected in the central court, the work of placing which must in itself have been somewhat of an engineering feat, all of them being of the heaviest modern type. The North British Railway Company shows a four-coupled bogie engine and accompanying tender, made at the Cowlairs Works. The cylinders are 18in., and stroke 26in., the weight being about forty-six tons in running order. The exhibit is one of six similar engines intended for traffic in the North, after the Tay Bridge is opened. Messrs. Dubs and Co., Glasgow Locomotive Works, and Neilson and Co., Hyde Park Works, Glasgow, each show a locomotive and tender made for the Caledonian Railway Company. That by Messrs. Dubs is noteworthy as being the first locomotive fitted with the Douglas valve motion. The engine and tender are fitted with the Westinghouse automatic air-brake, and the ordinary hand brake, which can be worked in connection with and independent of each other. This exhibit is designed to run the Royal Mail train between Carlisle and Aberdeen, a distance of 241 miles, over gradients 10 miles in length of 1 in 75 and 1 in 80. Messrs. Neilson and Co.'s engine and tender are slightly less weighty, the cylinders are 18in. and stroke 26in., with driving wheels 7ft. diameter. The fourth exhibit of this kind is by the Clyde Locomotive Company, of Springburn, Glasgow, and is intended for the Highland Railway Company. The engine has 18in. cylinders and 24in. stroke, four wheels coupled, with leading four-wheel bogie. In this section, also, the Caledonian and London and North-Western Railways exhibit a fine specimen of their composite carriages, constructed on Mr. F. W. Webb's system of radial wheel base, at the Wolverton Works of the London and North-Western Railway Company. The Edinburgh Street Tramways Company shows a tramway car designed and built by it at its works, Shrubhill, Leith Walk, in connection with which several interesting patent adjuncts are shown. The same company exhibits a section of permanent way construction, illustrating a patent system of strengthening the track by means of chilled iron blocks alternating with granite sets.

The machinery-in-motion section does not, of course, embrace all the exhibits coming within the machinery category, but machines are to be found more or less over the whole Exhibition. Often where manufactured articles or metals and minerals are displayed, examples of the machinery employed in making or in getting such are also shown. The number of such isolated machines is, however, limited. Stands of much general interest, though of secondary importance from an engineering point of view, are those devoted to practically illustrating manufacturing processes, with the machinery and appliances involved. In this way the manufacture of silk, straw hats, candles, velvet, glass-blowing and engraving, &c., are shown throughout the Exhibition. Several towns, taking up the suggestion of the Exhibition authorities, have erected "trophies" representing the leading industries and manufactures of their localities. In this way Greenock makes a most interesting display of its sugar refining, shipbuilding, engineering, and other branches of industry, the trophy taking the form of a pyramid very compactly and tastefully arranged. Dunfermline and Galashiels in the same way exhibit examples of the special products for which these towns are famed.

Allusion has already been made to the artisan section. This somewhat novel feature in connection with large international exhibitions must be said to be a very interesting section in the Edinburgh display. Workers in metal and cabinetmakers are largely represented, some of the exhibits in these branches being of much delicacy and neatness, while others are obviously the work of amateurs in the special branch of industry with which the exhibits are concerned. The central exhibit is an obelisk of brass, covered with shields bearing the arms of various towns in Scotland, the work of the operative brassfounders of Edinburgh. Numerous models of palaces, cathedrals, &c., in cork, also a large number of models of ships, including a well finished model of the Livadia, fishing craft, &c., and of marine engines, are shown, most of them of exceeding neatness. From the operative cutlers of Sheffield a large and very beautiful collection of cutlery has been sent to this section. Adjoining the artisan section a department has been arranged for the display of women's work, and it will be a revelation to most visitors to find the beauty and variety of exhibits shown, as well as the wide range of occupation which those exhibits show women to be capable of following. Copying the highly successful plan in the London Exhibitions of presenting "Old London" as faithfully as possible to modern eyes, the Edinburgh people have had prepared, from the designs of Mr. Sydney Mitchell, architect, a "bit" illustrative of "Old Edinburgh," having, need it be said, its own stirring historic associations as well as "Old London."

The arrangements for lighting the Exhibition buildings and surrounding promenades, band stand, and pavilions are very complete. The lighting has been divided into six sections, each being served by a different firm of contractors, except in the cases of the central court and the northern promenade outside, both of which sections are supplied by King, Brown, and Co., Edinburgh, the largest contractors. Their plant consists of ten dynamos driven by five Marshall and one Adamson engines, supplying the current to no fewer than 1425 incandescent lamps of 20-candle power in the central court, and 1200 of 10-candle power on the promenade outside. Another of the contractors is Mr. Richard Miller, of Glasgow, who fits, on the Thomson-Houston system, an installation composed of eight dynamos driven by two Robey engines, 30 and 40-horse power respectively, supplying the permanent pavilion with sixty-seven arc lamps, the north-west courts with eighty, and the main entrance with six arc lamps. The Gülcher Company, of London, has four dynamos supplying thirty-two arc lamps in the south-west courts and the incandescent lamps in the reception rooms and offices in the permanent pavilion. The Anglo-American Brush Company has four dynamos for fifty-five arc lights in the north section, and it has also two Victoria machines for lighting Old Edinburgh with 250 incandescent lamps. Messrs. Andrews and Co. have the largest dynamo in the Exhibition, weighing over four tons, and it provides for thirty-three arc lamps. In all there are thirty dynamos driven from twelve engines, and they supply the current to about 3150 lamps, equal, it is said, to what would be furnished by 570,000 candles. The foregoing notes of the electric lighting of the Exhibition are only very general, it being our intention to return to the subject and treat it in more detail, as well as that of the steam generators and prime movers in the Exhibition. It may be added that an electric railway has been laid down alongside the northern promenade, and two fine cars supplied by the North Metropolitan Tramway Company, London, will ply daily during the Exhibition.

Westburn Colliery Company, Glasgow, exhibits specimens of coal from its collieries on the Duke of Hamilton's estate near Hamilton. One is a block of the famous Ell coal, weighing 2 ton 11 cwt., full thickness of seam 5ft., got at 50 fathoms from surface. Section of main coal, 7ft. thick, piece 3 tons 4 cwt., 70 fathoms from surface, shipped to Mediterranean and other continental ports, &c. Splint coal, 85 fathoms from surface, 3½ft. thick, known in the various foreign markets as Duke of Hamilton's "best hard splint." Cannel coal, for gas production, giving a high illuminating power and a superior quality of coke. Samples of washed nut coal, for stoves, ranges, &c., largely used both in the home market and on the Continent. Washed pea coal, for steam raising purposes, effecting a great economy in comparison with ordinary dross. All the impurities are washed out of the coal. The heating power of washed as compared with unwashed coal is greater in direct proportion to the quantity of shale, &c., removed.

THE IRON AND STEEL INSTITUTE.

THE Iron and Steel Institute resumed its meeting on Thursday, the 13th inst., with a better attendance. The first paper read was by Dr. Percy, of which we give below an abstract. Its subject was—

STEEL WIRE OF HIGH TENACITY.

In his address to the Iron and Steel Institute in May, 1885, he mentioned steel wire of great tensile strength amounting to not less than 120 tons per square inch, and he also said that he had recently seen it stated that mild steel, in the form of rod or bar, had been produced of equal tensile strength, and he determined to search for trustworthy information on the subject. In October last year he, with Colonel Markham, R.A., and the members of the advanced class of artillery officers, visited the steam plough works of John Fowler and Co. at Leeds. His attention was particularly attracted to their steel wire ropes, for the excellence of which they have justly acquired a high and world-wide reputation. He was informed, to his astonishment, that the tensile strength of the wire amounted to 150 tons or more. Information was willingly imparted to him by Mr. Greig, the managing director, and one of the partners of the firm, who gave him a sample of the wire. He asked Colonel Maitland, R.A., to ascertain its tensile strength, and Sir Frederick Abel to ascertain its chemical composition. He presented the report of Colonel Maitland just as he received it. The kind of steel wire operated upon is that known as Fowler's Special. It is hard and extraordinarily tough, and so rigid that, even with the aid of pliers, it requires the exercise of considerable manual force to bend it. It breaks when bent on itself, and the fractured surface is ragged, without showing any appearance of grain. The following observations on the specific gravity of the wire have been made by Sir Frederick Abel's assistant, Mr. Deering.

The specific gravity of the wire at 60 deg. Fah., in its original state, that is, before Colonel Maitland began to operate upon it, was 7·8142, and after rupture 7·8082. The same weight of wire was used in both of these determinations; but, as it amounted only to about 8 grammes, Mr. Deering suggests that the difference between the two specific gravities may not be greater than the probable error of experiment. It is, however, a difference in the direction which might have been anticipated. The specific gravity of the wire was increased by annealing from 7·8082 to 7·8402, a difference also in the direction to be expected, though Mr. Deering again suggests that it may be within the limits of possible error. The process of annealing adopted was as follows:—The wire was in three pieces, each from 3in. to 3½in. long, which together weighed about 8 grammes, and were the same pieces as had served previously in the determination of the specific gravity after rupture or final straining in Colonel Maitland's experiments. They were packed round with asbestos—to check chilling—and pushed into a combustion tube about 8in. long. At each end of the tube a plug of copper gauze about 1½in. long was inserted, the pieces of steel wire and asbestos lying between those two plugs. One end of the tube was sealed, and the other drawn out fine. The tube having been thus arranged, and placed in a gas combustion furnace, the plugs of copper gauze were first heated to redness with a view of absorbing the oxygen in the tube; afterwards the pieces of wire and asbestos were heated to very full redness and kept at that temperature for half an hour. The gas was gradually lowered and then extinguished, after which the top of the furnace—the bottom and sides of which were of clay—was covered with a tin-plate screen and left until the following day, when the wires were withdrawn: they were slightly dulled on the outside, but quite superficially.

A table was given which shows weight applied, elastic and permanent extensions, and showing that the wire broke with between 153 and 154 tons per square inch, the wire being 0·093in. diameter.

The final elongation in the experiment immediately preceding rupture was, with load 1·1in., and without load 0·75in. A portion of the wire on which Colonel Maitland had operated was selected for chemical analysis, and gave: Carbon, total, 0·828 per cent.; manganese, 0·587 per cent.; silicon, 0·143 per cent.; sulphur, 0·009 per cent.; copper, 0·030 per cent.; phosphorus, *nil*. The wire was very carefully examined for chromium, titanium, and tungsten, but no trace of those metals was detected. Nearly the whole of the carbon, it may reasonably be inferred from the hardness of the wire, must have existed in the combined state. The percentage of carbon, it will be noticed, was greatly in excess of what is present in mild steel. Mr. Greig forwarded to him three samples of thicker steel wire of the same kind, 0·132in., 0·159in., and 0·191in. in diameter respectively. The tensile strength of each of these wires has been determimed. Colonel Maitland's results may be readily compared with each other, as follows:—

No.	Diameter in fractions of an inch.	Tensile strength in tons of 2240 lb.
1	0·093	154
2	0·132	115
3	0·159	100
4	0·191	90

Hence, it appears, that as the diameter increases, the tensile strength of the wire notably decreases. If the tensile strength of the metal, in Nos. 2, 3, 4, had been the same as in No. 1, it would be represented by the numbers 154, 309, 450, and 647, that is, calculating from the sectional areas of the wires respectively. The steel pianoforte wire which he received from Dr. Pole, and to which he had previously alluded, was of considerably less diameter than the thinnest of "Fowler's Special," and yet its tensile strength was much inferior, as it did not exceed 120 tons. Of the four samples presented by Dr. Pole, three, measured by the Birmingham wire gauge, were 0·035in., and the other 0·042in. in diameter. In December, 1885, the author was favoured with a letter from a correspondent, who, concerning the above results, remarked: "This breaking strain is certainly high; but if, as I expect, it was obtained in a wire of small diameter, say under ·060in., it is not at all extraordinary. I have often come across wire with a still higher breaking strain; and as a proof I send you enclosed some tests of wire, of which I am enabled also to enclose samples, so that you can convince yourself of the correctness of my results. From the original tests, and from the re-tests, you will observe that three of the wires, 0·019in. diameter, show throughout, with only one exception, a breaking strain of over 160 tons per square inch, whereas the other three wires are throughout weaker." The wire was tinned, and the writer remarks: "Of course all the diameters are measured over the tin, but the layer of tin is so thin that it may well be neglected in the calculations." Some tests of high steel wire 0·03in. diameter gave 169·9 tons ultimate strength.

The information which he had been able to collect is such as to incline us not to accept without hesitation the accuracy of the statement, that mild steel in the form of rod or bar has been produced of the same strength as Dr. Pole's wire, which, it will be remembered, amounted to 120 tons. The interesting question—Why is it that steel only, when in the form of comparatively fine wire, should be capable of acquiring such a high degree of tenacity?—remains to be solved. Is it that during the process of wire-drawing a more intimate interlocking, so to speak, of its particles may occur, which increases its resistance to the tearing asunder of those particles? That such resistance is enormously augmented is certain, but if it were due to the cause which he had just ventured to suggest another difficulty arises; for how, it may be asked, can a more intimate interlocking of its particles be reconciled with the fact that its specific gravity, so far from being increased, as in that case might reasonably be anticipated, is actually decreased, or, what is equivalent, its volume is augmented.

A short discussion followed Dr. Percy's paper. Mr. T. Blair read the second paper, which was "On certain accessory Products of Blast Furnaces." This was taken with a paper by Mr. Hilary Bauerman, V.P.G.S., entitled, "Note on a Rare Blast Furnace Slag of the Composition of Gehlenite." Both these papers are of much metallurgical interest, the former showing how numerous, and often unnoticed, are the subsidiary and accidental metals and products of blast furnace operations, the latter leading to important inferences concerning the greater quantity of heat used with certain mixtures and aluminous ores.

The next paper read was by Mr. J. Head, assistant to Mr. Frederick Siemens, on "Blow-holes in Open-hearth Steel." The ostensible object of this paper was to broach what the author seemed to think a new explanation of the cause of unequal strength in mild steel. To do this he had to speak of "puzzling behaviour" and fractures of a "mysterious character," and in explanation, he brought forward the old notions concerning the effect of blow-holes visible and microscopic, and the similarity of their origin to that of the "seedy boil" in glass. He then came to what seemed to be the real object of the paper, namely, to describe the Siemens continuous glass melting process and furnace. The "seedy boil" in glass was overcome by using a furnace in which glass was melted out of contact with flame—*ergo*, use a Siemens radiant heat furnace for steel melting, and the "seedy boil," or, at all events, the blow-hole source of variation in the strength of steel will be gone. The furnace was illustrated by diagrams on the wall.

In the discussion on the paper, Mr. Tannett Walker spoke almost indignantly of the paper, as saying what was not true of steel, merely to bring forth an old notion as to cause of weakness, and with it a new furnace.

Mr. Windsor Richards said he had had steel varying between 0·10 to 0·15 per cent. of carbon in different parts of ingot, and tried to get over this and sponginess by poling, but found that pouring the molten steel from one ladle to another and back was the best means.

Mr. J. Riley spoke of the bogey Mr. Head had tried to raise; of the efficacy of pouring the steel from one ladle to the other, and of the necessity for keeping plates as small as possible.

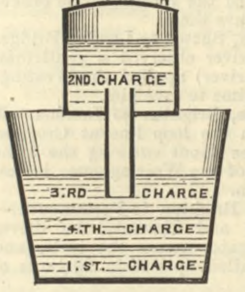
Mr. W. Parker said that it was a question of manipulation, and not of material, which had been raised. The author, he said, had gone back to 1881, and a subject that had been cleared up and done with. One thing alone would show that the microscopic blow-holes had not much effect on the steel. Steels with more or less variable tensile strength were improved and made uniform by annealing. If the weakest pieces were originally weak by blowholes, they could not reach the strength of the others by being annealed. He agreed with Mr. J. Riley as to small plates. He had seen very long plates come from the mill buckled, because of the greater extension by rolling of the centre parts than the edges. These plates he had seen put in the cold bending rolls, and the buckles eliminated. He asked, Where has the material that was in the buckle gone? As to steel plates generally, he spoke in the highest terms, and said that they had made the propulsion of ships 20 per cent. cheaper than a few years ago.

Mr. Cowper spoke of the effect when a harder and a more rigid plate got used in connection with softer and more ductile plates. The latter stretch; the former will not, and gets the load and breaks before the soft plate can take up its share of the work.

Mr. Greig spoke with cynical indignation at what he appeared to think impertinence in lecturing the Institute about blow-holes and seedy boil in bottle glass, or at all events in bringing forward a paper on a thrashed subject and referring for text to very old facts.

Mr. Nathaniel Barnaby said there was one aspect in which the paper had great possible importance, namely, the production of good sound steel castings, a subject of much more real importance than was usually supposed. The furnaces and results described led to a hope that such castings might become possible. There should be no reason why cast shafts should not be procurable, and would certainly easily be better than those which developed a star-shaped longitudinal fracture throughout in working up.

Mr. Rapier explained an apparatus he had made for removing the gases from molten steel, and by which some improvement had been effected, and the density of the steel increased. The apparatus consisted of an air vessel placed over a large ladle, and attached to an air pump. Four charges of steel were run into the ladle, and, as may be supposed, more or less stratified. The air vessel was then lowered into the molten metal, the nozzle reaching the bottom of the second. The air pump was set to work, and the metal rose into the air vessel. This was then raised, the vacuum gradually spoiled, the metal allowed to go back steadily, and then another charge was taken up from a higher level. In this way gases were removed.



At the end of the discussion on this paper the meeting adjourned to Friday.

THE WESTINGHOUSE BRAKE.

A NOVEL and very interesting feature in the Board of Trade returns on continuous brakes, for the half-year ending December, 1885, is the statement to be found in the appendix, showing the accidents prevented by the use of the Westinghouse brake on the London and Brighton Railway, so far as ascertained. A great deal has been heard of the so-called "failures" of brakes published in the Board of Trade returns; and it is quite refreshing to be able to read such a record of the "successes" of at all events one of the systems in use. It will be noted that in nearly all cases the result shows to the credit of the driver, and we are therefore left to imagine the number of additional cases in which risks have been run by the driver's own negligence or mistakes, and which have been rectified by the use of the brake. The list as it stands, however, appears to us most significant and suggestive, and gives one, perhaps, a better idea of the anxieties and dangers attending railway working, than any number of reports on investigated collisions, &c. The record of a remarkable escape is, in fact, often more impressive than would have been the account of the disaster. The public at all events will now more easily understand what it is that Mr. Westinghouse has accomplished; and such a record even from one line out of hundreds using his brake must be very highly gratifying. The London and Brighton Railway Company must also be congratulated on having been one of the first to adopt such an appliance; and on the care and attention it has given to keeping the apparatus in order, as well as in assisting the Board of Trade by compiling such a record as that which we append.

The return of the half year's working of the brake on the Brighton line offers a very favourable comparison to that from the Midland Railway Company, which still uses the Westinghouse brake in working its Scotch traffic from London to Carlisle. Whereas the Midland Company with 405 vehicles fitted can only run 6000 miles per report, the London and Brighton Company having 2642 vehicles can cover 87,000 miles! This confession of incompetence on the part of the former is but little to the credit of a company which prides itself on its enterprise and business capacity.

The following is the statement showing the cases of accidents, so far as ascertained, which have been prevented by the use of the Westinghouse brake from January, 1881, to the 31st December, 1885:—

January 17th, 1881: The 8.5 a.m. train from Loughborough Park to London Bridge.—When leaving Peckham Rye the distant signal at Queen's-road was at "danger," and on the driver preparing to stop, the signalman improperly lowered it. A dense fog prevailed at the time. On arriving within about thirty yards of the station, the driver noticed a train standing at the platform. He applied the Westinghouse brake, and managed to stop just clear of the train at the platform, and so avoided a collision.

January 17th: The 8.8 a.m. train, South Croydon to Victoria.—When approaching Battersea Pier station during a dense fog, the driver perceived another train immediately in front of him, standing at the Battersea Pier platform. By the application of the Westinghouse brake, the driver was enabled to pull up his train about an engine's length from the rear of the train in front, and so avoided a collision.

January 24th: The 7.50 a.m. train, Brighton to London.—The driver was signalled to start from Brighton, but after going some distance he saw the Kemp Town train approaching. He applied the Westinghouse brake, and stopped within about three or four yards of the other train, and so avoided a collision. It was very foggy at the time.

February 15th: The 11.25 a.m. train, Portsmouth to Brighton.—After leaving the high-level station at Portsmouth—the signals being "off"—the driver saw a London and South-Western train running into the low-level station; he applied the Westinghouse brake and avoided a collision.

April 13th: The 5.45 p.m. train, Victoria to London Bridge.—Was running into London Bridge station after the signals, which were "on" at A B box, had been lowered, when he was again signalled to stop, and the driver applied the Westinghouse brake just in time to avoid a collision with an engine which was obstructing the road.

May 31st: The 10.25 a.m. train, Brighton to Horsham.—On approaching Bramber distant-signal, the driver saw a cow on the line in the way of the train; he immediately applied his Westinghouse brake, and pulled the train up clear of the obstruction.

July 26th: The 5.21 a.m. train, Whitechapel to New Cross.—When between Whitechapel and Shadwell, and near the mouth of the tunnel, the driver observed a large and heavy piece of timber obstructing the line immediately in front of him; he applied the Westinghouse brake and stopped the train, and removed the obstruction.

August 20th: The 4.40 p.m. train, Portsmouth to London.—Soon after leaving Horsham, the driver observed a horse and van without anyone in charge, running on the line coming towards him. He applied the Westinghouse brake, and stopped just clear of the obstruction.

September 2nd: The 2.10 p.m. train, Worthing to London.—On approaching Lancing station, the driver observed a lady and a gentleman riding on horseback, crossing the line at a road crossing, immediately in front of the train; by applying the Westinghouse brake he managed to stop the train clear of them.

September 12th: The 11.25 a.m. train, Hastings to Brighton.—On approaching an occupation crossing soon after leaving Pevensey, a man improperly drove some cattle across the rails. The driver applied the Westinghouse brake, and brought the train to a stand in time.

September 17th: The 5.50 p.m. train, Sutton to London Bridge.—On approaching the platform at West Croydon, a lady and a gentleman imprudently attempted to cross the line immediately in front of the engine. The driver applied the Westinghouse brake, and stopped the train just in time to save them.

September 17th: The 5.50 p.m. train, Sutton to London Bridge.—When approaching Brockley, the driver observed a gentleman fall from the platform, and he (the driver) applied the Westinghouse brake and stopped the train in time to save him.

October 13th: The 11 a.m. express, Brighton to London.—A horse-box was by mistake standing in the loop line at Croydon when the train was signalled, and was about entering the same line, but the train, by the application of the Westinghouse brake, was stopped in time to avoid a collision.

October 22nd: The 1.5 p.m. train, Brighton to Portsmouth.—When running between Emsworth and Havant, the driver observed the Warblington crossing gates across the rails, and applying the Westinghouse brake, pulled up within 20 yards of them.

October 22nd: The 10 p.m. train, Liverpool-street to New Cross.—In approaching Canal Junction, the driver saw the signals were all "off," when, on passing the distant signal, he saw the tail lights of another train in front; he applied the Westinghouse brake, and stopped within about a train's length from the preceding train, and so avoided a collision.

December 13th: The 7.25 p.m. train, London Bridge to West Croydon.—A lady walked off the platform at West Croydon—the weather being very foggy—but the train was, by the application of the Westinghouse brake, stopped in time to prevent injury to her.

January 18th, 1882: The 11.5 a.m. train, London Bridge to Battersea Park.—After leaving London Bridge, the signals being all right, and when nearing South Bermondsey intermediate signals, the driver saw another train about 50 yards ahead. He immediately applied the Westinghouse brake, and stopped when about 12 yards from the other train, so avoiding a collision.

February 13th: The 7.50 p.m. train, Eastbourne to London.—As this train was leaving the Eastbourne station, a passenger named Field, in attempting to enter the train, slipped and fell between the carriage and platform. The guard perceiving this, immediately applied the Westinghouse brake, which instantly stopped the train, and prevented the wheels of the carriages passing over the passenger.

February 28th: The 1.50 p.m. fast train, London to Portsmouth.—When running between Sutton and Cheam, the driver observed a pack of foxhounds on the line; he applied the Westinghouse brake, and pulled up the train in time to prevent an accident.

April 5th: The 11 a.m. up express, Portsmouth to London.—As this train was running at its usual speed of between 40 and 50 miles per hour, between Leatherhead and Ashtead, the driver suddenly observed that a platelayer had taken out a length of rail without having first taken the usual precautions to block the line. The driver immediately applied the Westinghouse brake, and was enabled to stop the train clear of the place where the rail had been taken out, thereby avoiding a serious accident.

July 11th: The 2.30 p.m. train, London to Portsmouth.—On approaching No. 64 gates near Emsworth they were found closed. Driver applied Westinghouse brake and stopped clear of them.

August 21st: The 9.8 a.m. train, London to Sutton.—As this train was approaching the Sutton Station platform, and when within a very short distance of the platform, the driver saw a workman—a painter—standing on a ladder which had been improperly placed on the line on which the train was approaching. By the application of the Westinghouse brake the driver was enabled to pull up the train clear of the ladder and the man upon it.

September 25th: The 3.40 p.m. train, Brighton to Hastings.—When running between Polegate and Willingdon Junction, driver saw a man driving sheep over a level crossing; driver applied Westinghouse brake and stopped clear.

October 21st: The 5.45 p.m. Pullman car train, Brighton to Victoria.—When running out of Brighton station, driver saw another engine standing foul of the line; he applied the Westinghouse brake and stopped clear of the engine, and so avoided a collision.

November 25th: The 11.40 a.m. fast train, London to Portsmouth.—When running between Dorking and Lodge Farm, driver saw hounds and huntsmen on line; he applied the Westinghouse brake, and stopped just clear of them.

May 31st, 1883: The 8.50 a.m. train, Brighton to Portsmouth.—When approaching Port Creek Bridge, driver saw some Marine Artillerymen, with horses and baggage wagon, crossing the line at the Occupation Crossing, south of the bridge; he applied the Westinghouse brake, and stopped just clear of them.

May 31st:—The 1.45 p.m. express train, Victoria to Portsmouth.—When approaching Pulborough station, the driver saw two children improperly crossing the line from one platform to the other, the station-master at the same time having jumped on to the line to rescue them. The driver at once applied the Westinghouse brake, and came nearly to a stand, thereby enabling the children to be safely removed.

June 2nd: The 8 p.m. boat express train, London to Newhaven.—A seaman belonging to the Brighton Company's steam packet fleet, in running across the line at the Newhaven station platform, caught his foot between the rails and some points. The man was unable to extricate his foot, and two other servants of the company ran to his rescue, but their united efforts were unable to get the man's foot released, and in agony of despair he clung to the other two men, so much so that all the three were in very imminent danger of their lives; but the driver of the approaching train, seeing what had happened, applied the Westinghouse brake, and managed to stop the train within a yard or two clear of the three men.

July 10th: The 1.50 p.m. train, Brighton to Eastbourne.—After passing Southerham Junction, driver saw a man with a team of horses and a load of hay crossing the line at the first farm level crossing. He whistled and applied the Westinghouse brake, and brought his train to a stand a few yards from them.

August 26th: The 8.25 a.m. special excursion, London to Portsmouth.—In approaching the yard signal-box at New-cross, at a speed of about 50 miles per hour, the driver saw a goods engine standing upon and obstructing the line at the station platform in front of him. He immediately applied the Westinghouse brake, and pulled up in time to avoid what would otherwise have been a very serious collision.

September 6th: Special empty train, from New-cross to Crystal Palace.—On approaching Crystal Palace station, while the signal was "off," the driver observed another train standing upon the same line of rails outside the station. He at once applied the Westinghouse brake, and succeeded in stopping his train, thereby avoiding a collision.

September 11th: The 6.37 a.m. train, Addiscombe to Liverpool-street.—On approaching Whitechapel station, while the signal was "off," the driver observed another train standing upon the same line of rails at the station. He applied the Westinghouse brake, and succeeded in stopping his train, whereby a collision was avoided.

September 11th: The 12.10 p.m. fast train, London to Hastings.—While running between Cooksbridge and Lewes, at about 45 miles per hour, the axle of the leading wheels of the tender broke, the wheels left the rails and damaged the ordinary hand-brake gear of the engine so that it was rendered useless; the driver, however, applied the Westinghouse brake, and was thereby enabled to bring the train to a standstill in safety.

November 20th: The 10.55 a.m. Hastings to Brighton.—When approaching St. Leonard's, the driver saw a woman walking along the line immediately in front of the train. He applied the Westinghouse brake, and brought his train to a stand in time to prevent accident to her.

December 14th: The 9.8 a.m. Streatham Common to London.—When running between New Cross and Bricklayers' Arms Junction, the driver observed a company's workman in the 4ft. way with a plank of wood on his back. He applied the Westinghouse brake and brought his train to a stand, thus enabling the man to get out of the way.

December 18th: The 4.55 p.m., Victoria to Portsmouth.—When nearing Portsmouth Harbour Station, the driver noticed the tail lamps of a South-Western train immediately in front of him; he applied the Westinghouse brake, stopping clear of the train.

December 26th: The 4.0 p.m., London Bridge to Portsmouth.—This train was stopped by signal outside Portsmouth Harbour station, and afterwards received the signal to enter, but on running into the station the driver observed a South-Western Company's train standing loading at the platform. The driver, as soon as he saw the train, applied the Westinghouse brake, and thus avoided what might have been a serious accident.

December 31st: The 9.32 p.m., New Cross to Liverpool-street.—The train was stopped by hand signal when running into Whitechapel station, by reason of a man and a woman having fallen off the platform. These parties were under the influence of drink, and struggling on the ballast, when another passenger, observing their perilous position, jumped also from the platform to rescue them, and the train being pulled up by the use of the Westinghouse brake when about 25 yards distant only, averted what might have been a very serious accident.

January 14th, 1884: The 2.35 p.m. London to Victoria.—When running into Victoria the driver saw a man on a ladder, painting a signal-box, the ladder fouling the line on which the train was running. Driver whistled and applied the Westinghouse brake, and the man had just sufficient time to get out of the way, the engine stopping about two or three yards clear of him.

January 18th: The 3.20 p.m. Brighton to Haywards Heath.—When in the cutting at north end of Patcham tunnel, the driver saw a pack of hounds on the line. He applied the Westinghouse brake and succeeded in stopping clear of them.

February 2nd: The 11.10 a.m. Newhaven to London.—When passing Tinsley Green, the driver saw a party of hunters and staghounds crossing the line. He shut off steam and applied the Westinghouse brake, thereby avoiding an accident.

March 6th: The 1.56 p.m. Tunbridge Wells to Brighton.—After leaving Eridge, the driver, in rounding a curve, saw a trolley with two of the company's workmen on it coming towards him. He applied the Westinghouse brake and stopped just clear.

March 15th: The 1.5 p.m. Victoria to Brighton.—When running into Leatherhead the driver saw a child standing between the four-feet way and the platform. He applied the Westinghouse brake, and thereby succeeded in stopping before he reached it.

March 20th: The 10.10 p.m. London to Epsom.—Just after passing Cheam station the driver saw a young lady with a child in her arms, about 75 yards ahead, step on the line just before she came to the overhead arch. He immediately applied the Westinghouse brake, and she, seeing the train at the same moment, only just cleared it by a few inches.

April 8th: The 10.20 a.m., Whitechapel to Peckham Rye.—When running into Shadwell station, the driver saw some platelayers in the tunnel waving hand lamps. He shut off steam and applied the Westinghouse brake and immediately brought the train to a standstill, when he found a man had suddenly fallen upon the line in the way of the train.

May 23rd: The 12.10 p.m. London to Hastings.—When approaching Beddingham gate crossing, the driver saw some cattle on the line. He immediately applied the Westinghouse brake, and succeeded in bringing his train to a stand just before reaching them.

June 23rd: The 10.30 a.m. Brighton to East Grinstead.—When running between Horsted Keynes and West Hoathly, the driver saw a man—a trespasser—lying in the 6ft. way, with his legs across the metals in front of his engine. He applied the Westinghouse brake, and succeeded in bringing the train to a stand before running over the man, whom he found to be asleep.

August 9th: The 5.8 p.m. Three Bridges to Tunbridge Wells.—When running between Groombridge and Tunbridge Wells, the driver saw a team of horses and a wagon on the line, about 100 yards in front of the engine; he applied the Westinghouse brake, whereby the team had just time to get clear.

August 18th: The 10.30 a.m. Hastings to Victoria:—When between Polegate and No. 25 gate crossing, the driver saw a wagon and horses on the line; he applied the Westinghouse brake, and brought the train to a stand when about two yards from the obstruction.

August 29th: The 9.25 p.m. West Croydon to Victoria.—When entering Victoria station, the signals being off to allow train to run in No. 2 road, the driver saw a light engine standing in the same road; he applied the Westinghouse brake, and stopped when about two engines' length distance from the light engine.

September 4th: The 8.40 a.m. Barnham Junction to Brighton.—When running into Worthing station, a porter, who was wheeling a barrow over the crossing, was caught by an empty train shunting on the down line and thrown across the up line; the driver applied the Westinghouse brake, and stopped when about one yard from the porter.

September 13th: The 8.57 a.m. Brighton to London.—When running between Preston Park and Hassocks, the driver saw a pack of hounds on the line; he applied the Westinghouse brake, and thereby succeeded in bringing the train to a stand without injuring them.

September 30th: The 12.10 p.m. London to Hastings.—When running between No. 25 gate crossing and Polegate, the driver saw some bullocks on the line; he applied the Westinghouse brake, and stopped without injuring them.

October 8th: The 3.20 a.m. New Cross to Portsmouth.—On approaching Bedhampton signals, which were off, the driver saw a platelayer's trolley on the line. He applied the Westinghouse brake, and stopped when about 12 yards from the obstruction.

November 14th: The 1.45 p.m. Brighton to London.—When approaching Ouse Valley Viaduct, the driver saw a deer and some hounds on the line running towards his train; he applied the Westinghouse brake, and stopped before he reached them.

November 20th: The 6.40 a.m. London to Polegate.—On approaching Lewes the signals were off, but when in the curve of the tunnel the driver observed the red tail lights of a goods train standing in front of him; he immediately applied the Westinghouse brake, and succeeded in so lessening the force of the collision that the only damage which occurred was a draw-bar hook breaking.

November 22nd: The 11.0 a.m. Portsmouth to London.—When going round a curve between Ockley and Holmwood, the driver saw some huntsmen and hounds crossing the line, and just in front of him; he immediately applied the Westinghouse brake, and brought the train to a stand in time to prevent an accident.

December 5th: The 2.30 p.m. Tunbridge Wells to Eastbourne.—When running between Eridge and Rotherfield, the driver saw two horses on the line in the way of the train, but he succeeded in stopping the train with the Westinghouse brake without accident.

March 16th, 1885: The 1.45 p.m. Brighton to London.—When about half a mile north of Three Bridges, driver was enabled to stop the train by means of the Westinghouse brake, to avoid running over some deer-hounds which came suddenly across the line.

July 10th: The 3.27 p.m. Victoria to Eastbourne.—When running at a speed over 50 miles per hour, between Berwick and Polegate, the driver saw a team of bullocks and a wagon crossing the line immediately in front of him at a level crossing; he applied the Westinghouse brake and stopped just in time to avoid an accident.

July 15th: The 2.38 p.m. Dorking to London.—On approaching south end of Penge station, driver saw a passenger improperly crossing the line in front of the engine, and in attempting to jump on the platform, fall back on the line; driver at once applied the Westinghouse brake, and stopped in time to prevent an accident.

July 16th: The 12.39 p.m. East Croydon to Victoria.—On approaching Balham station platform, driver saw a female standing in a very dangerous position in the way of the train; he immediately applied the Westinghouse brake, and stopped in time to prevent accident to the passenger.

August 11th: The 8.30 p.m. London to Victoria.—When approaching Battersea Park station, the driver saw a red light exhibited, and applied the Westinghouse brake, and stopped short of the platform, a passenger having fallen from the platform on to the line.

August 28th: The 5.47 p.m. London to Dorking.—When running between Epsom and Ashtead, the driver saw a horse on the line, about 150 yards ahead; he applied the Westinghouse brake, and stopped in time to prevent an accident.

September 20th: The 4.15 p.m. London to Dorking.—When running between Leatherhead and Box Hill, the driver saw two horses on the line; one of them fell down and the other ran towards the engine, but the driver applied the Westinghouse brake, and prevented an accident.

September 23rd: The 7.26 p.m. Peckham Rye to Liverpool-street.—When rounding the curve, on entering Liverpool-street, all signals being "off," driver saw an engine and truck about 50 yards in front of him; he applied the Westinghouse brake and prevented a collision.

December 5th: The 12.14 p.m. Hayward's Heath to Brighton.—When approaching Folly Hill a pack of hounds ran on to the line, about 200 yards in front of the engine; the driver applied the Westinghouse brake and succeeded in stopping without accident.

December 21st: The 11.40 a.m. Horsham to London.—When running between Leatherhead and Ashtead, the driver saw some sheep on the line, but by means of the Westinghouse brake he stopped clear of them.

December 24th: The 10.30 a.m. Brighton to London.—When running between Crowhurst Junction and Oxted, driver saw some fox-hounds on the line; he applied the Westinghouse brake and stopped in time to prevent train running over them.

The following is a statement of the number of engines and passenger train vehicles fitted with the Westinghouse automatic brake, and regularly in work, up to December 31st, 1885:—Engines (passenger 283, goods 40), 323; vehicles, 2642.

The following shows the actual number of times the Westinghouse brake has been applied in the ordinary working of the trains on seven separate days in 1883, 1884, and 1885, namely:—Thursday, April 5th, 1883, 16,460 applications of the brake; Thursday, July 26th, 1883, 17,747; Saturday, January 19th, 1884, 16,774; Saturday, July 5th, 1884, 18,798; Monday, November 10th, 1884, 19,013; Thursday, July 21st, 1885, 20,238; Thursday, November 26th, 1885, 19,102.

These recorded tests of the working of the brake on the above days are intended to show that not only has the train been fitted up with the brake, but that it has been in full working operation throughout its journey. This information has been furnished to the Board of Trade in the Brighton Company's returns to that department each half-year. J. P. KNIGHT, General Manager.

General Manager's Office,
London Bridge Terminus, S.E., January, 1886.

TENDERS.

FOR gasworks—exclusive of builders' work—at Mitcham, Surrey, for the Guardians of the Poor of the Holborn Union. H. Saxon Snell and Son, architects, London.

	If gasholder tanks are of Brick.	Iron.
	£	£
Holmes and Co.	2490*	3635
Porter and Co.	2625	3515
May Brothers	2875	3695
Berry and Sons	3010	3860
Cutler and Sons	3117	3796
R. and J. Dempster	3146	4046
Ashmore, Benson, Pease, and Co.	3550	4871
Renshaw, King, and Co.	3679	3629
R. Dempster and Sons	—	4050

* Accepted.

THE REGULATION OF RAILWAYS ACT.—The twelfth annual report, for 1885, of the Railway Commissioners has just been issued as a parliamentary paper, as required by the 31st section of the Act of 1873. The appendices added contain—(1) the judgments delivered by the Commissioners on eleven applications made to them in the course of the year; (2) a list of three working agreements approved by them; and (3) a report of the decision given by Mr. Justice Wills and Mr. Justice Mathew in the case of "Hall and Company *v.* the London, Brighton, and South Coast Railway," in the Queen's Bench Division on June 30th, 1885.

LAUNCH OF THE ORIZABA.—This vessel was recently launched by the Barrow Shipbuilding Company for the Pacific Steam Navigation Company's trade between Liverpool and Valparaiso. The vessel was christened Orizaba by Miss Robinson, sister to the chairman of the company, as she left the ways, and is one of the finest the shipbuilding company have turned out since the City of Rome. She is 460ft. in length, 49ft. in breadth, 38ft. 3in. in depth, and has a gross registered tonnage of 6500. The ship has been built under the survey of both Lloyd's and Liverpool underwriters, and will receive the highest class in those registers. The hull has been constructed on the longitudinal double-bottom principle, and fitted in four complete closed in decks all fore and aft, and a promenade deck extending to the vessel's side. The Orizaba will carry in the cabins and saloons, which are being fitted up in the best possible style, 124 first, 54 second, and 412 third-class passengers, besides officers and crew. She will be propelled by inverted direct-acting triple expansion engines of 6000 indicated horse-power, the diameter of the high-pressure cylinder being 40in., intermediate cylinder 60in., and low-pressure cylinder 100in., with a stroke of 6ft., adapted for a working pressure of 160 lb. per square inch. The apartments are to be lighted with 400 incandescent electric lights.

RAILWAY MATTERS.

A BALANCED slide valve has been under trial on an American railway, and the result claimed is a saving of 30 per cent. of fuel, the load being the same with and without the balanced valve. It has, however, been pointed out that the load was sometimes carried by a much shorter train than at others, and that short trains were coincident with the saving.

A DEVICE has been invented by which electricity is made to record the weights indicated upon scales or steelyards, the application being specially designed for the weighing of goods wagons while in motion. It is said that, with this device properly applied to the scales, an accurate account can be kept of the weight of every wagon passing over them, even at full speed.

MAJOR-GENERAL HUTCHINSON reports on the accident which occurred on the 3rd March at Merthyr station, on the Great Western Railway, when a passenger train from Hirwain to Merthyr came into collision with the buffer stops at the end of that line, and injured seven passengers. The report is Hutchinsonian, and makes a recommendation that would spoil the thing he recommends. He says: "Had the engine as well as the train been fitted with continuous brake appliances, with the rule that the continuous brake should not be used for running into terminal stations except in case of emergency, the train might have been stopped short of the buffer stops, notwithstanding the error of judgment which led to the present collision." He would make a brake useless by making it an emergency or never-ready brake.

THE American *Railroad Gazette* record of train accidents in March contains brief accounts of 22 collisions, 55 derailments, and 4 other accidents; a total of 81 accidents, in which 49 persons were killed and 131 injured. Two collisions, 15 derailments, and 1 other accident caused the death of one or more persons each; 8 collisions and 13 derailments caused injury to persons, but not death. In all, 18 accidents caused death and 21 injuries, leaving 42, or 52 per cent. of the whole number, in which there was no injury serious enough to record. The 22 collisions killed 3 persons and injured 15. In the 55 derailments 45 persons were killed and 116 injured; while in the 4 other accidents 1 person was killed. Of the killed 42 and of the injured 52 were railroad servants, who thus furnished 86 per cent. of the killed, 40 per cent. of the injured, and 52 per cent. of the whole number of casualties. As compared with March, 1885, there was a decrease of 5 accidents, but an increase of 32 in the number killed and of 47 in that injured.

"A CORRESPONDENT," says an American Exchange, "wants to know how much coal there may be in a mile of loaded coal cars. In reply, we can say that a 5-ton car or coal jimmy is 11ft. 6in. in length from bumper to bumper. An 11-ton car is 22ft. 1in. A car holding from 14 tons to 16 tons of anthracite is 24ft. 2in. A gondola of 20 tons capacity is put at 27ft. 4in. A large gondola with 25 tons capacity is 32ft. in length. Now then for the quantity. The *Coal Trade Journal* says there will be about 460 of the jimmies to the mile, and that means 2300 tons of coal, perhaps. There will be 240 of the double jimmies, and that means perhaps 2640 tons. There will be 218 of the large cars, and that may mean 3270 tons. Of the gondolas there will be 193 cars, and this may mean 3840 tons. Then of the larger ones there are, say, 160 cars, which will equal in capacity 4000 tons. All this goes to show that when you see or hear of a mile or two of cars standing loaded, it really does not mean so very much coal."

THE annual report of the Agricultural Department of the Privy Council Office, says, "The reports received from the travelling inspectors of the department regarding the arrangements made for the transit of animals by the several railway companies of Great Britain bear evidence of the commendable attention and care now given to this subject by the companies. Both the railway trucks in which the animals are carried, and the pens in which they are detained before or after transit, are, as a rule, regularly and effectually cleansed, any neglect in this direction being exceptional. The conditions under which animals are now carried by railway show a marked contrast to those which existed some ten years since when the present staff of travelling inspectors were first appointed. The overcrowding of trucks, more especially those used for the conveyance of sheep, still occasionally occurs, but less frequently than formerly. No instance has been reported of freshly shorn sheep having been carried unclothed during the winter months in uncovered or unenclosed vehicles, so as to expose the animals unnecessarily to the weather."

A GENERAL classification of the accidents on the American railways last March is made as follows by the *Railroad Gazette*:—

	Collisions.	Derailments.	Other.	Total.
Defects of road	—	17	—	17
Defects of equipment	3	9	4	16
Negligence in operating	17	2	—	19
Unforeseen obstructions	2	12	—	14
Maliciously caused	—	6	—	6
Unexplained	—	9	—	9
Total	22	55	4	81

Negligence in operating is thus charged with 23 per cent. of all the accidents, defects of road with 21, and defects of equipment with 20½ per cent. A division according to classes of trains and accidents is as follows:—

Accidents.	Collisions.	Derailments.	Other.	Total.
To passenger trains	1	20	3	24
To a pass. and a freight	5	—	—	5
To freight trains	16	35	1	52
Total	22	55	4	81

This shows accidents to a total of 103 trains, of which 30—29 per cent.—were passenger trains, and 73—71 per cent.—were freight trains.

AN account of the accident which occurred in October last on the rack railroad going from Arth, at the foot of the celebrated Rigi, to the top of that mountain, says the train consisted of one locomotive, two loaded freight cars, and a small passenger car, probably all coupled together in order that the cars might pass more easily over the less severe grades, which were covered by thick layers of snow. This coupling together of cars and engine is strictly prohibited on the Rigi railroad, and was not justified in the present case, but this rule is often violated. The train in question was a work train in charge of the roadmaster. The freight cars were loaded with lumber in such a manner that the brake wheels could not be reached. A fireman stood at the brake of the passenger car, but jumped off before putting on the brake. When the train reached the lower end of the Kraebelwand, where no snow was lying, and which is 1¼ miles from the lower station, the men heard a heavy crack, followed immediately by a great increase of the speed of the train. The labourers on the platform of the car jumped off shortly after they had heard this noise, and farther on the roadmaster did the same. The train ran away, passed with lightning speed and deafening noise a distance of about 2100ft., including several curves, and left the track a short distance below the watering station Kraebel, going over a precipice to a meadow below. The locomotive turned three times, once lengthwise and twice crosswise, and stood then again upright on the wheels. The freight cars probably followed the engine and were thrown around its circle of 1000ft. The broken coupling was found between the engine and the first freight car. The coupling of the passenger car was also torn off, and the car probably left the track with one wheel soon after the accident; it was thrown entirely off the track further down, and stood on its wheels in front of the freight cars; the roof and sides of the cars were scattered around. The boiler and the cylinders of the engine remained intact, the rest of the engine being almost entirely destroyed. The track is not damaged to any extent; this proves again how strongly the rack rails are constructed. The immediate cause of the accident was the breaking of the working shaft, which had an old crevice 7in. long and about 0·1in. deep. A similar break of the engine shaft occurred at the same place several years ago, but the brakes were applied at once, and the train was stopped.

NOTES AND MEMORANDA.

M. JANSSEN has completed an installation of tubes for analysing the influence of the atmosphere on spectroscopic analysis and absorbing power. Their length is 100 metres, and they can be filled with gas under a pressure of 100 atmospheres. The light is supplied by a battery of sixty Bunsen elements.

IN London during the week ending the 8th inst. 2706 births and 1491 deaths were registered. The births were 131 and the deaths 161 below the average of the last ten years. The annual death-rate per 1000 was 18·7. During the first five weeks of the current quarter the death-rate averaged 19·0, and was 3·6 below the mean rate in the corresponding periods of the ten years 1876-85.

AT the Paris Academy of Sciences, on May 3, a paper was read "On the Magnetic Principle," by M. Mascart. The author's theoretical studies lead to the general inference that in a magnetic and isotropic body of any form there are three rectangular directions, for which the magnetic force is parallel to the outer field with different coefficients. These coefficients possess the same properties as those of a sphere of slightly magnetised anisotropic substance. For steel the mean coefficient of longitudinal magnetic force is much weaker than for soft iron; hence the increased importance of transverse magnetisation.

THE report of Mr. William Crookes, F.R.S., Mr. William Odling, F.R.S., and Dr. C. Meymott Tidy, on the water supplied to London last month, says that "during April, as during the preceding month of March, the condition of the water was in all respects entirely satisfactory. As regards the degree of freedom from excess of organic matter, the mean proportion of organic carbon in the Thames-derived supply was ·160 part in 100,000 parts of the water, with a maximum of ·189 part and a minimum of ·130 part in any one sample; the above mean proportion of organic carbon corresponding to less than three-tenths of a grain of organic matter per gallon.

SOME interesting statistics of the Japanese press have lately been published in the *Oesterreichische Monatsschrift für den Orient*, in which the newspapers and periodicals of Japan are arranged according to the subjects with which they deal. It appears, says *Nature*, that thirty-seven publications are devoted to matters connected with education, and that these have a total circulation of 42,649 per month. There are seven medical papers, with a monthly circulation of 13,514; nine relating to sanitary matters, with a circulation of 8195; two on forestry, and two on pharmacy. There are seven devoted to various branches of science, with a circulation of 2528; but to these must be added twenty-nine engaged in popularising science, with a total circulation of 70,666.

A PROCESS for the preservation of the active principles of hops intended for use in breweries has recently been brought before the French Academy by M. Boulée. It consists in separating mechanically the lupulin from the bracts forming the strobiles, exhausting the bracts deprived of lupulin with boiling water, and mixing intimately the lupulin and the dry powdered extract. The mixture is to be enclosed in tin cans, in which air is replaced by carbonic anhydride. In this condition it is said to keep indefinitely, and the loss sustained through the hops losing their aromatic properties by the conversion of the essential oil into valerianic acid is avoided. The *Brewers' Guardian* suggests that this process is the same as is adopted in the manufacture of normal hops, a preparation referred to some two years ago, and specimens of which were shown at last year's Brewers' Exhibition.

AT the recent meeting of the Berlin Physical Society, Dr. Pernet gave a brief historical survey of the undertakings carried out in Paris at the end of last century by an International Congress, which, after theoretically determining on the kilogramme and the metre as normal units, produced a normal metre and normal kilogramme of platinum. The speaker discussed the events which in 1878 led to a new international agreement, in consequence of which a new normal metre of platinum-iridium of X-form was prepared and compared with the metre of the Archives. A series of national standards was also compared with the normal metre. The speaker described in a clear manner the arrangements of the Bureau in which the comparisons were undertaken, the contrivances for securing the several comparing rooms against outward disturbances, the means adopted for insuring constant temperatures, and the methods employed in the comparisons, as also in the determination of the expansion coefficients of the rods used. Finally he gave a sketch of his own labours, which had for their object the comparison of a series of normal metre rods of different metals with the metre of the Archives, and the determination whether repeated heatings and coolings between 50 deg. and 0 deg. C., whether concussions, and whether time caused any perceptible changes in the length of the rods. As the result of these investigations, it was found that the compared national standards, together with their divisions, were exact up to one-thousandth of a millimetre; that, with the exception of steel, which, on account of its changes in hardness, readily yielded modifications of volume and length in the rods made of this material, all the metals out of which the standards were made—namely, platinum-iridium, platinum, and brass—furnished material suitable for normal metre rods; and that repeated heatings and concussions induced no changes passing beyond the limits within which observation falls.

MR. DOUGLAS ARCHIBALD has communicated to the British Association some results of observations with kite-wire suspended anemometers up to 1300ft. above the ground in 1883-85. Since the first series of observations taken in 1883-84 he made twenty-five fresh observations at heights above the ground varying from 300ft. to about 1300ft., or double the greatest height before attained. In ten of the new observations the upper anemometer was suspended at a height of over 1000ft. above the ground, or 1500ft. above the sea. To exhibit the law of change of the velocity with the height, he computed for each observation the value of the corresponding exponent in the empirical formula $\frac{V}{v} = \left(\frac{H}{h}\right)^x$, where V, v, H, h, are the velocities and heights of the upper and lower instruments respectively. The several groups, together with their corresponding heights, mean velocities, and exponents, are given in the following table:—

Group.	Number of observations.	Mean height of upper instrument above ground, in feet.	Mean height of lower instrument above ground, in feet.	Mean height of both.	Mean velocity at both heights in feet per minute.	Mean upper and lower velocities. Upper	Mean upper and lower velocities. Lower	Mean value of x.
1	7	250	102	176	1895	1617	1174	0·372
2	3	322	128	225	1955	2232	1679	0·307
3	8	407	179	293	1545	1705	1885	0·275
4	5	549	252	400	1940	2107	1773	0·237
5	9	795	481	638	2074	2192	1957	0·250
6	10	1095	767	931	2166	2236	2096	0·194

The general and obvious conclusion to be drawn from this table, as well as from the individual observations—in which a reverse case has never occurred—is that the velocity of the wind always increases from the surface of the ground up to 1800ft. above sea-level, and that the ratio of the increase steadily diminishes up to that height. The only exception to the steady decrease in the value of x occurs in Group 5, and this is evidently due to the inclusion in that group of an abnormally large value of x (0·576), corresponding to an equally abnormally small velocity of 789ft. per minute, which is little more than a third of the mean velocity of the stratum corresponding to that group.

MISCELLANEA.

MESSRS. C. ISLER AND CO.'s elliptical turnstiles have been selected for use at the Liverpool International Exhibition.

OWING to the breaking of a dam, several quarters of the Merv have been flooded, causing some destruction of property. The necessary repairs have, however, been effected.

To improve the wearing resistance of the wood pavements put down in London streets, it is common to throw a coating of gravel over the newly-paved roadway. This is a good idea, but if instead of throwing a thick coating over the roadway a coating of not more than ¼in. in thickness were used, a much more rapid arrival at the desired result would be made.

AT the close of 1885 the number of lifeboats under the management of the National Institution was 290, through the instrumentality of which 371 lives were saved during the year, besides twenty vessels. Rewards were also granted by the Institution for the rescue, by shore-boats, of 184 other persons, making a grand total of 555 lives rescued within the year by means of the society.

THE *Fifeshire Advertiser* says for the last few days this unusually quiet place—Crossgates—has been elicited (?) by the arrival day after day of four monster steam boilers which are intended for the new works of Mr. Ord Adams. The boilers are each 30ft. long by 7½ft. in diameter, of the Lancashire type, and are made of Siemens-Martin steel, to work at 80 lb. per square inch. They come from Messrs. Wm. Wilson and Co., Glasgow.

THE *Railroad Gazette* says:—"The Pintsch Lighting Company is equipping the two new boats of the Hoboken Land and Improvement Company with its compressed gas appliances, and is also laying 7000ft. of high-pressure pipe and equipping the Fourteenth-street, Hoboken, Ferry House with the necessary gas plant for same company. It is also building a new compressor for the gasworks of the New York, Providence, and Boston Railroad at Stonington."

THE Queen of Spain recently witnessed a public trial of a steam fire engine of the Greenwich pattern, constructed by Merryweather and Sons, of London, and which took place at the Royal Palace, Madrid, on the 4th inst. *La Epoca* states that the Greenwich engine worked with great success, and threw 4000 litres per minute to a height of 60 metres. Steam was raised in four minutes from time of lighting the fire, and to 100 lb. working pressure in seven or eight minutes.

THE Government is inviting tenders for the construction of a breakwater at Portrush. The projected breakwater will be 430ft. long, and the channel which it encloses will be deepened so as to form a suitable harbour for large fishing boats. A similar harbour and breakwater is now in course of construction at Portstewart. The *Coleraine Constitution* says the boon which the existence of two such harbours on this coast will confer upon the fishermen can scarcely be over-estimated.

MESSRS. WHITTAKER AND CO. and Messrs. Bell announce in their new "Series of Handbooks for Engineers," Dr. Jul. Maier's book on "Arc and Glow Lamps," giving the latest results and improvements. The next volume in the same series will be Mr. Gisbert Kapp's "Electric Transmission of Energy," which is promised early next week. Mr. Wm. Anderson has revised and added some new matter to his "Lectures on the Conversion of Heat into Work," which excited much attention when delivered last year at the Society of Arts. They will be published in book form by Messrs. Whittaker and Co.

THE first experiment at the Colonial and Indian Exhibition in washing and manipulating the "blue ground," imported from the Griqualand West Diamond Mines, took place under the direction of Sir Charles Mills, K.C.M.G., acting executive commissioner for the Cape of Good Hope, in the Cape Court of the Exhibition, on Saturday afternoon, May 15th, in the presence of a number of visitors, amongst whom were the Duke of Manchester, the Right Hon. Osborne Morgan, M.P., Sir John Swinburne, M.P., and others. Several diamonds were found in the course of the operation, which attracted a considerable crowd and excited an unusual amount of interest. The process will be repeated at stated times during the period of the Exhibition.

THE French Minister of Commerce has decided, subject to the approval of scientific men and specialists, to erect, either at the entrance, or at some other part of the Paris Exhibition, the gigantic metallic tower proposed by M. Eiffel, the eminent engineer. It will be 300 metres in height, and constructed entirely of iron. It will rest on five pillars, forming four immense arcades, lofty enough to exceed in height the towers of Notre Dame. On the summit of the tower will be erected an electric lighthouse, and a terrace to which visitors will be admitted. The tower is expected not only to be an extraordinary source of attraction to the building, but to render important services to science. It is suggested that meteorological and astronomical observations will be made at the summit under entirely novel conditions. An electric signal, placed on the summit of the tower, may be seen in clear weather at Dijon—a fact which will give the erection great importance in connection with military signalling and national defence.

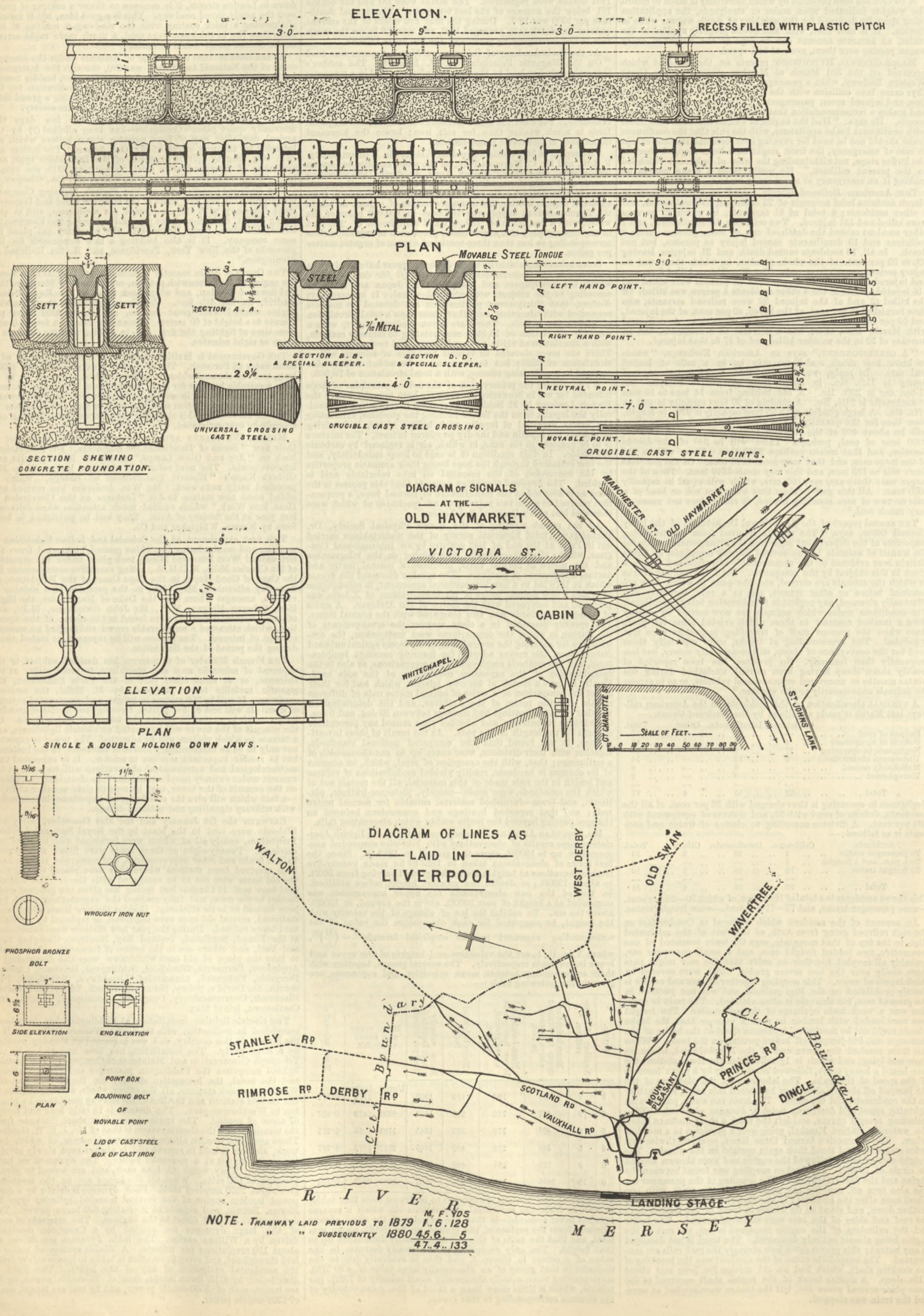
BETWEEN the 1st January and the 31st December, thirty new lifeboats were sent to the coast by the Royal National Lifeboat Institution, nearly all of which were furnished with transporting carriages. Twenty-eight of these boats were fitted with water-ballast tanks and other improvements, and numerous reports have been received from stations where they were placed stating that the old boats were not to be compared with them. The sliding-keel boat sent to Clacton last spring has given the greatest satisfaction to the crew, and fully realised the expectations which had been formed as to its efficiency. Besides the new boats which were stationed, several old ones were improved, or replaced by partially used boats refitted. During the year new stations were established at the Lizard, Southend, Totland Bay, Montrose, Cloughey Bay, and Peel, and others are in the course of formation. New boats, to take the place of old ones withdrawn were also despatched to Appledore, Barmouth, Blackpool, Bridlington, Brixham, Clacton, Ferryside, Fishguard, Llanddulas, Llanddwyn, Newbiggin, Plymouth, St. David's, Selsey, Sidmouth, Silloth, Tenby, Ballywalter, Blackrock, Courtmacsherry, Drogheda, Groomsport, Youghal, and Castletown, Isle of Man.

THE electric lighting installation at Paddington has just been completed in connection with the Great Western Railway. It is the largest in this country, and was inspected on Monday evening by a large party. The installation has been undertaken by the Telegraph Construction and Maintenance Company. The district lighted comprises the Paddington passenger and goods stations, and the hotel, the locomotive station, the Royal Oak and the Westbourne-park stations, all the offices, yards, and approaches to the various stations and the line of the railway itself from Paddington to Westbourne-park. The district is 1½ mile long and covers 67 acres of ground. The engine house is a short distance from the terminus, and the electric system is that of Mr. J. E. H. Gordon. There are three Gordon alternate current dynamos, of which two work, and one is held in reserve and is always kept slowly revolving ready for use at a moment's notice. The dynamos we have illustrated. They weigh 45 tons each, and are wound to give a pressure of 150 volts. When all the lamps are on the machines give about 2000 ampères each. Each dynamo is driven by a compound tandem engine of the vertical inverted cylinder type by Messrs. Rennie, and capable of indicating 600-horse power. The dynamos are coupled direct to the engines. The magnets of each of the large dynamos are excited by a Crompton machine, driven by a Willans engine. The main dynamos are driven at about 150 revolutions per minute. A double system of mains is laid throughout, and every precaution is taken to insure safety from the accidental extinction of any of the lights. The light is distributed by 4115 Swan lamps, each of 25-candle power, by 98 arc lamps, each of 3500-candle power, and by two arc lamps, each of 1200-candle power.

THE TRAMWAYS OF LIVERPOOL.

MR. C. DUNSCOMBE, M.I.C.E., ENGINEER.

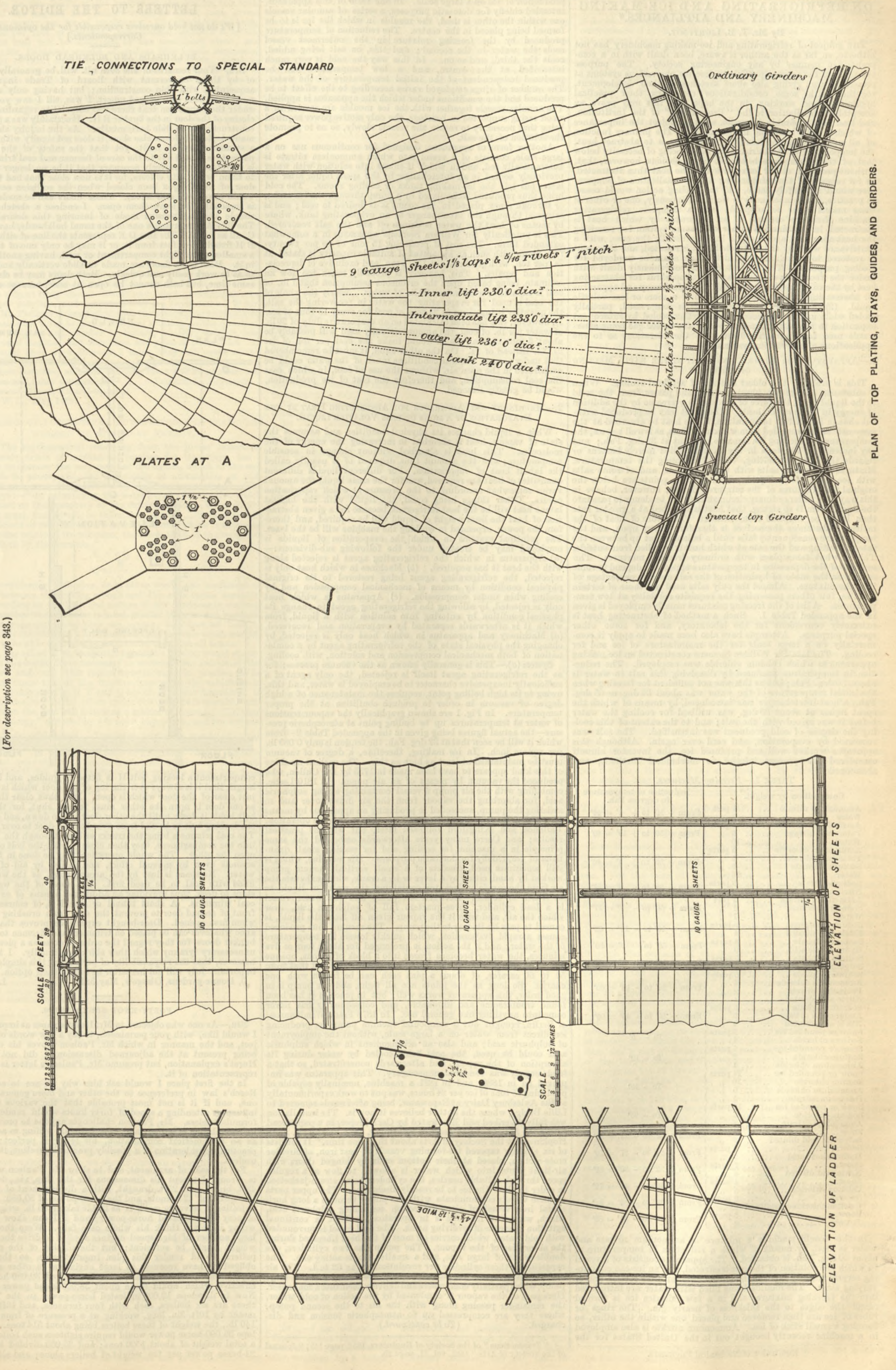
(For description see page 402.)



THE BIRMINGHAM GAS WORKS.—240FT. GAS HOLDERS.

MR. CHARLES HUNT, M.I.C.E., BIRMINGHAM, ENGINEER.

(For description see page 343.)



ON REFRIGERATING AND ICE-MAKING MACHINERY AND APPLIANCES.*

By Mr. T. B. LIGHTFOOT.

THE subject of refrigerating and ice-making machinery has not hitherto, so far as the author is aware, been dealt with in a comprehensive manner by any engineering society. The purpose therefore of the present paper is to describe the various systems at present in use, giving also short sketches of their development, together with some considerations respecting their practical application and working, in the hope that this may prove an acceptable contribution to the "Proceedings" of the Institution, and lead to a profitable discussion upon a subject the importance of which is daily becoming more manifest. The primary function of all refrigerating and icemaking apparatus is to abstract heat, the temperature of the refrigerating agent being of necessity below that of the substance to be cooled. It is obvious, however, that, without provision either for rejection of the heat thus abstracted, or for renewal of the refrigerating agent, equalisation of temperature would ultimately ensue, and the cooling action would cease. In practice, if the machine is to work continuously, one or other of these means must be adopted; and a complete refrigerating machine therefore consists of an apparatus by which heat is abstracted, in combination either with some system for renewing the heat-absorbing agent, or, as in more usually the case, with a contrivance whereby the abstracted heat is rejected, and the agent is restored to a condition in which it can again be employed for cooling purposes. The subject can be conveniently dealt with under the four following heads:—(1) Apparatus for abstracting heat by the rapid melting of a solid. (2) Machinery and apparatus for abstracting heat by the evaporation of a more or less volatile liquid. (3) Machinery by which a gas is compressed, partially cooled while under compression, and further cooled by subsequent expansion in the performance of work; the cooled gas being afterwards used for abstracting heat. (4) Considerations as to the applications of the various systems.

1.—APPARATUS FOR ABSTRACTING HEAT BY THE RAPID MELTING OF A SOLID.

This is probably the oldest method of artificial cooling. When a substance changes its physical state, and passes from the solid to the liquid form, the force of cohesion is overcome by the addition of energy in the form of heat. The effect may be produced without change in sensible temperature, if the heat be absorbed at the same rate as it is supplied from without. Thus, as is well known, the temperature of melting ice remains constant at 32 deg. Fah.; and any increase or decrease in the heat supplied merely hastens or retards the rate of melting, without affecting the temperature. Mixtures of certain salts with water or acids, and of some salts with ice, which form liquids whose freezing points are below the original temperatures of the mixtures, do not, however, behave in this way; for under ordinary circumstances the tendency to pass into the liquid form is so strong, that heat is absorbed at a greater rate than it can be supplied from without. The store of heat of the melting substances themselves is therefore drawn upon, and the temperature consequently falls until a balance is set up between the rate of melting and the rate at which heat is supplied from outside. This is what takes place with ordinary freezing mixtures. The amount of the depression in temperature appears to depend to some extent on the state of hydration of the salt and the percentage of it in the mixture. Almost the only salts used are those of certain alkalies, few others possessing the requisite solubility at low temperatures. A list of the freezing mixtures usually employed is given in the appended Table I. Such a method of abstracting heat is extremely convenient for the laboratory, and for some other special purposes. Attempts have also been made to apply it commercially on a large scale for the manufacture of ice and for cooling. The late Sir William Siemens constructed an ice-making apparatus in which calcium chloride was employed. The reduction in temperature produced by dissolving this salt in water is about 30 deg. Fah.; but as this was not sufficient for freezing when the initial temperature of the water was about 60 deg. or 65 deg. Fah., a heat interchanger was introduced, by means of which the spent liquor at about 30 deg. was utilised for cooling the water before it was mixed with the salt; and to the extent of this cooling the degree of cold produced was intensified. The salt was recovered by evaporation, and used over again. Although this apparatus worked well and produced ice, the inventor himself considered the process inferior to mechanical methods, and abandoned it.

TABLE I.—*Freezing Mixtures.*

Composition by weight.*		Reduction of temperature in degrees Fah.
Ammonium nitrate	1 part	From + 50° to + 4° = 46°
Water	1 „	
Ammonium chloride ..	5 parts	From + 50° to + 10° = 40°
Potassium nitrate	5 „	
Water	16 „	
Ammonium chloride ..	5 parts	From + 50° to + 4° = 46°
Potassium nitrate.. ..	5 „	
Sodium sulphate	8 „	
Water	16 „	
Sodium nitrate	3 parts	From + 50° to − 3° = 53°
Nitric acid diluted ..	2 „	
Ammonium nitrate ..	1 part	From + 50° to − 7° = 57°
Sodium carbonate ..	1 „	
Water	1 „	
Sodium phosphate ..	9 parts	From + 50° to − 12° = 62°
Nitric acid diluted ..	4 „	
Sodium sulphate	8 parts	From + 50° to 0° = 50°
Hydrochloric acid.. ..	5 „	
Sodium sulphate	5 parts	From + 50° to + 3° = 47°
Sulphuric acid diluted	4 „	
Sodium sulphate	6 parts	From + 50° to − 10° = 60°
Ammonium chloride ..	4 „	
Potassium nitrate ..	2 „	
Nitric acid diluted ..	4 „	
Sodium sulphate	6 parts	From + 50° to − 40° = 90°
Ammonium nitrate ..	5 „	
Nitric acid diluted ..	4 „	
Snow or pounded ice ..	2 parts	To − 5°
Sodium chloride	1 „	
Snow or pounded ice ..	5 parts	To − 12°
Sodium chloride	2 „	
Ammonium chloride ..	1 „	
Snow or pounded ice ..	24 parts	To − 18°
Sodium chloride	10 „	
Ammonium chloride ..	5 „	
Potassium nitrate.. ..	5 „	
Snow or pounded ice ..	12 parts	To − 25°
Sodium chloride	5 „	
Ammonium nitrate ..	5 „	
Snow..	8 parts	From + 32° to − 23° = 55°
Sulphuric acid diluted	3 „	
Snow..	8 parts	From + 32° to − 27° = 59°
Hydrochloric acid ..	5 „	
Snow..	7 parts	From + 32° to − 30° = 62°
Nitric acid diluted ..	4 „	
Snow..	4 parts	From + 32° to − 40° = 72°
Calcium chloride	5 „	
Snow..	2 parts	From + 32° to − 50° = 82°
Calcium chloride crystallised	3 „	
Snow..	3 parts	From + 32° to − 51° = 83°
Potash	4 „	

In the Toselli machine a mixture of ammonium nitrate and water is used, by means of which a reduction in temperature of about 40 deg. Fah. is obtained. The apparatus consists of a vessel in which the solution of the salt is effected, and an ice-can containing several slightly tapering moulds of circular cross section and of varying sizes. The moulds being filled with water are introduced into the freezing mixture, and in a few minutes ice is formed round the edges to the thickness of nearly ⅛in. The rings or tubes of ice are then removed and placed one within the other, so forming a small stick of ice. Ammonium nitrate is also employed in a machine recently brought out in the United States for the production of ice on a large scale. In one form of this apparatus, intended chiefly for domestic purposes, a series of annular vessels one within the other is used, the moulds in which the ice is to be formed being placed in the centre. The reduction of temperature produced by the freezing mixture in the outermost vessel cools the water in the second; and this, on salt being added, cools the third, and so on. In this way the cold is very much intensified at the centre, and a low temperature can be produced independent of the initial temperature of the water. The number of rings employed varies according to the effect to be produced and the conditions under which the apparatus is applied. The annular vessels together with the ice moulds are carried in a wood casing supported on bearings, the only motive power required being that necessary to rotate the vessels slowly, so as to promote the solution of the salt.

* Institution of Mechanical Engineers.

Another form of apparatus, designed for continuous use on a large scale, consists of a vessel into which ammonium nitrate is automatically fed, and in which it enters into solution with water previously cooled in an interchanger by the spent liquor after the latter has left the ice-making tanks or cooling rooms. The cold brine thus produced is circulated by a pump through the ice tanks, or through pipes placed in the rooms it is desired to cool; and is returned through the interchanger to an evaporating tank, where by means of heat the water is driven off and the salt recovered. This is practically Sir William Siemens' apparatus in a somewhat extended form. The cost of producing 15 tons of ice per twenty-four hours with such an apparatus of suitable capacity is stated at 7s. per ton, with good coals at 15s. a ton, and exclusive of depreciation and repairs. This, however, is probably much too low an estimate, being based upon the erroneous assumption that 1 lb. of coal is capable of evaporating 20 lb. of water. Nearly the whole of the coal is used for evaporating the water in recovering the salt, the quantity being given at 2½ tons of coal for every 15 tons of ice. If, however, this has been calculated on an evaporative duty of 20 lb. of water per lb. of coal, the amount actually used will probably be about 5 tons of coal, which would make the cost per ton of ice 9s. 3d. instead of 7s. On the other hand, it must be remembered that under certain climatic conditions much of the water could be evaporated in the open air, without the use of fuel, in which case the coal consumption, and therefore the cost of ice production, would be greatly lessened.

2.—MACHINERY AND APPARATUS FOR ABSTRACTING HEAT BY THE EVAPORATION OF A MORE OR LESS VOLATILE LIQUID.

When a liquid changes its physical condition and assumes the state of vapour, heat is absorbed in increasing the energy of the molecules. This heat is absorbed without change in sensible temperature; and the amount thus disposed of is usually called the latent heat of vaporisation. For different liquids different quantities of heat are required, and for the same liquid the amount varies somewhat according to the pressure at which vaporisation occurs. Other things being equal, the liquid with the highest latent heat will be the best refrigerant, because for a given abstraction of heat the least weight of liquid will be required, and therefore the power expended in working the machine will be the least. The principal systems in which the evaporation of liquids is employed may be treated under the following sub-divisions:—(*a*) Apparatus in which the refrigerating agent is rejected along with the heat it has acquired. (*b*) Machines in which heat only is rejected, the refrigerating agent being restored to its original physical condition by means of mechanical compression and by cooling when under compression. (*c*) Apparatus in which heat only is rejected, by allowing the refrigerating agent to change its physical condition by entering into solution with a liquid, from which it is afterwards separated by evaporation and recovered. (*d*) Machinery and apparatus in which heat only is rejected, by changing the physical state of the refrigerating agent by a combination of both mechanical compression and solution, with cooling.

System (*a*).—This is generally known as the vacuum process; for as the refrigerating agent itself is rejected, the only agent of a sufficiently inexpensive character to be employed is water, and this, owing to its high boiling point, requires the maintenance of a high degree of vacuum in order to produce ebullition at the proper temperature. In Fig. 1 are shown graphically the vapour tensions of water at temperatures up to boiling point at atmospheric pressure—the actual figures being given in the appended Table 2—from which it will be seen that at 32 deg. Fah. the tension is only 0·089 lb. per square inch. In ice making, therefore, a degree of vacuum must be maintained at least as high as this. The earliest machine of this kind appears to have been made in 1755 by Dr. Cullen, who produced the vacuum by means of an air pump. In 1810 Leslie, combining with the air pump a vessel containing strong sulphuric acid, for absorbing the vapour from the air drawn over and so assisting the pump, succeeded in producing an apparatus by means of which 1 lb. to 1½ lb. of ice could be made in a single operation. Vallance and Kingsford followed later, but without practical results; and Carré many years afterwards embodied the same principle in a machine for cooling and for making small quantities of ice, chiefly for domestic purposes. His machine, which is still sometimes used, consists of a small vertical vacuum pump worked by hand, either by a lever or by a crank, which exhausts the air from the carafe or decanter containing the water or liquid to be frozen or cooled. Between the pump and the water vessel is a lead cylinder, three-quarters full of sulphuric acid, over which the air, and with it the vapour given off from the liquid, is caused to pass on its way to the pump. The vacuum thus produced causes a rapid evaporation, which quickly lowers the temperature of the water; and if the action is prolonged for about four or five minutes, the water becomes frozen into a block of porous, opaque ice. The charge of acid is about 4½ pints, and it is said that from 50 to 60 carafes, of about a pint each can be frozen with one charge. So long as the joints are all tight, and the pump is in good order, this apparatus works well; but in practice it has been found troublesome and unreliable, and consequently has never come into anything like general use. In 1878 Franz Windhausen, of Berlin, brought out a compound vacuum pump for producing ice direct from water on a large scale, without the employment of sulphuric acid; and also an arrangement in which sulphuric acid could be used, the acid being cooled by water during its absorption of the vapour, and afterwards concentrated, so that a fresh supply was rendered unnecessary. This apparatus was improved on in 1880, and in 1881 a machine, nominally capable of producing 15 tons of ice per 24 hours, was put to work experimentally at the Aylesbury Dairy at Bayswater, being afterwards removed to Lillie Bridge, where the author believes it now is. The installation was fully described and illustrated by Carl Pieper, in a paper read before the Society of Engineers in November, 1882, and by Dr. John Hopkinson at the Society of Arts about the same time.* It consists of six slightly tapered ice-forming vessels of cast iron, of circular cross-section, closed at their bottom ends by hinged doors with air-tight joints, into which water is allowed to flow at a regular speed through suitable nozzles, the cylinders being steam-jacketted in order to allow the ice to be readily discharged. The upper parts of these vessels communicate with the pump through a long horizontal iron vessel of circular section containing sulphuric acid, which, when the machine is in operation, is kept in continual agitation by means of revolving arms. The acid vessel is surrounded with cold water, which carries off most of the heat liberated during the absorption of the vapour. The pump has two cylinders, one double-acting of large size, and a smaller single-acting one. The capacities of these cylinders per revolution are as 62 to 1. The air and whatever vapour has passed the acid are drawn into the large pump, which partially compresses and delivers them into a condenser. Here part of the vapour is condensed by the action of cold water, the remainder passing along with the air to the second pump, where they are compressed up to atmospheric tension and discharged. (*To be continued.*)

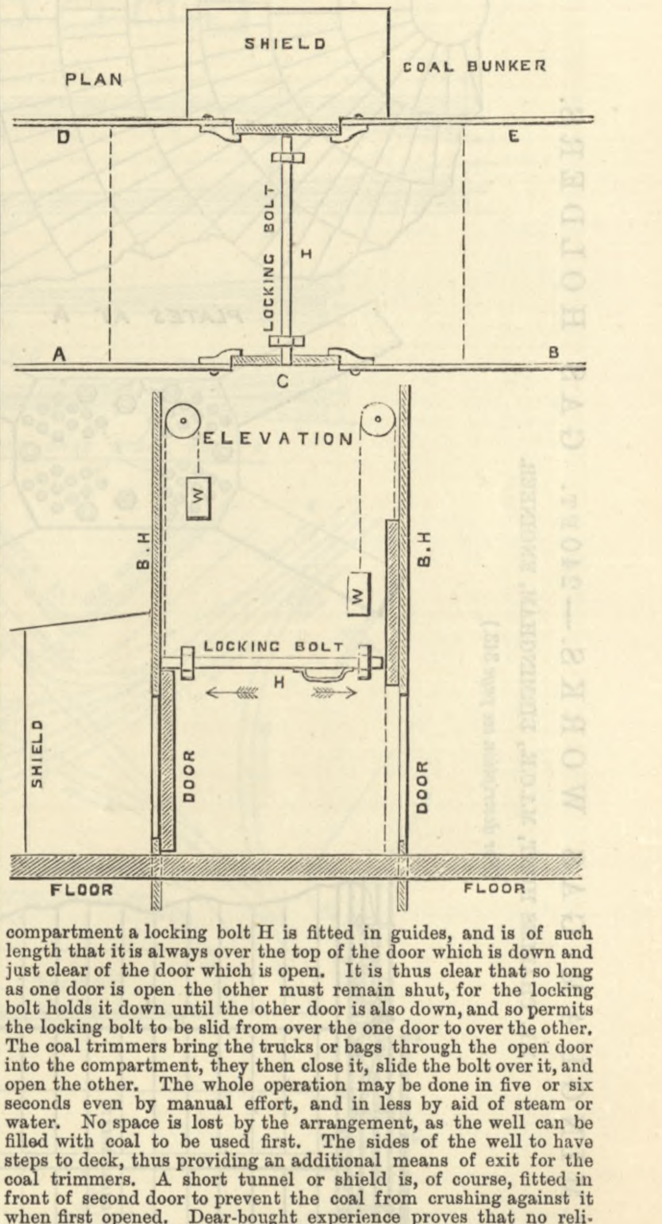
* "Transactions" of the Society of Engineers, 1882, page 145; "Journal of the Society of Arts," 1882, vol. 31, page 20.

LETTERS TO THE EDITOR.

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

BULKHEADS AND BULKHEAD DOORS.

SIR,—Your remarks of the 30th ult. will be generally approved of by those conversant with Board of Trade inquiries and acquainted with ship construction; but having only read what must have been an abridged report, I was, till I saw your article, under the impression that there was culpability regarding the non-closing of the door in the bunker B H. It certainly was a grave error constructing it to slide horizontally. As the inquiry showed, and many deplorable losses also show, it does not signify with what care a steamer may be built, yet that the safety of the ship and passengers is still left to the care of firemen and coal trimmers. It is therefore imperatively necessary that it be no longer left either to them or to petty officers, for it is now clear that had the bunker door of the Oregon been closed when the collision occurred she would have been still afloat. These doors can be made so that it is impossible to leave them open. I enclose a sketch of a very simple and inexpensive mode of insuring this desirable result. The line A B represents one of the usual bulkheads, having a door C, all as usual. The line D E represents the line of either another B H fitted a few feet from it, or it may be only one of the sides of a smaller water-tight compartment or well, having another door F in it. Both these doors are made to slide vertically and balanced so as to work easily and quickly. Both doors may be closed at the same time, but both cannot be open at once, because across this



compartment a locking bolt H is fitted in guides, and is of such length that it is always over the top of the door which is down and just clear of the door which is open. It is thus clear that so long as one door is open the other must remain shut, for the locking bolt holds it down until the other door is also down, and so permits the locking bolt to be slid from over the one door to over the other. The coal trimmers bring the trucks or bags through the open door into the compartment, they then close it, slide the bolt over it, and open the other. The whole operation may be done in five or six seconds even by manual effort, and in less by aid of steam or water. No space is lost by the arrangement, as the well can be filled with coal to be used first. The sides of the well to have steps to deck, thus providing an additional means of exit for the coal trimmers. A short tunnel or shield is, of course, fitted in front of second door to prevent the coal from crushing against it when first opened. Dear-bought experience proves that no reliance whatever can be placed on trimmers and firemen to shut the bunker doors, for they regard the order to do so as a piece of most unnecessary tyranny which they shirk continually. I hope now, however, that the responsibility of performing this simple but most important duty will not hereafter be left in their option.

5, Doune-gardens, Glasgow, May 3rd. L. HILL.

FORTY-KNOT SPEED SHIPS.

SIR,—As one who objected to Mr. Hurst's paper as impracticable, I would like, with your permission, to say a few words on the subject, and the manner in which Mr. Paulson proves his case. Not being present at the adjourned discussion, I did not hear Mr. Hurst's explanation, but presume Mr. Paulson's letter is a faithful representation of it.

In the first place I would ask him why we are to accept Mr. Reech's law in preference to the other and more generally known one, and if it is not most probable that the various disturbing influences attending a speed of forty knots would render both the formulæ useless. Mr. Paulson challenges anyone to prove wherein his calculation is wrong; and I am perfectly willing to admit that, as an arithmetical computation, his letter is perfect; but as a practical consideration of a possibly practical question, it is almost useless.

For the sake of argument, and to show Mr. Paulson wherein he is wrong, I accept his dimensions for the ship, viz., 440ft. long, 48ft. broad, and 25ft. draught, with a displacement of 3360 tons, the speed of 43·5 knots, and the horse-power of 30,080. The first objection I have to make is as to his taking 60 lb. weight of machinery per indicated horse-power; and if I can show that he is wrong in this, I think his whole case fails. Were there a very large number of high-speed engines applied to drive the ship, this weight might be sufficient; but the placing of the many propellers would render this plan impracticable, so that we are obliged to have recourse to large engines as in other ships. To obtain the speed mentioned there is required 30,080-horse power effective, which would mean about 36,000-horse power indicated. Now to develope 12,000 indicated horse-power in the Trafalgar, there are six boilers, each with four furnaces, and 16ft. 2in. diameter by 10ft. 3in. long, working at a pressure of from 134 lb. to 140 lb., the weight of these boilers being about 514 tons. To develope 36,000-horse power would require eighteen such boilers, having a total weight of about 1500 tons; and 36,000 divided by 1500 = 24-horse power per ton weight of boilers alone; and allowing the engines to be two-thirds of the weight of the boilers, the total weight of the engines and boilers would be 2500 tons, giving 14·4-horse power per ton of machinery. The displacement being 134·4 tons per foot of draught, 2500 divided by 134·4 = 18·5ft. which the hull will be immersed by the machinery alone, and accepting Mr. Paulson's weight of coal as 1629·4 tons, depressing the vessel 12·12ft., and a further depression of 5·9ft., which he also allows for the weight of the hull, we have 18·5 + 12·12 + 5 9 = 36·52ft. draught, or a minus quantity of 11·52ft. I have in this calculation given a greater efficiency and horse-power per ton of machinery than has yet been obtained in any of our war-ships, more effectually to show where Mr. Paulson is wrong; and if Mr. Paulson has faithfully worked out Reech's law, it also shows that the law is very far out with the practice of the day.

Having sunk the ship, it is scarcely necessary to proceed further with the subject, but it may be worth while to consider what other difficulties have to be encountered. The engines of the Trafalgar are triple expansion, with cylinders of 43in., 62in., and 96in. diameter, and 51in. stroke, and developing 6000-horse power each. If we make our engines for the "forty knotter" of double the power, *i.e.*, 12,000-horse—and it would be almost impossible to make them larger for want of head-room, and having to keep the cylinders low for safety from shot, &c.—we then have three sets of engines, developing 36,000-horse power combined; but there is a difficulty in placing the propellers, and it is questionable if more than two propellers are of any use. If the engines can be enlarged to 18,000-horse power each, the question arises, Is it possible, with a limited diameter of screws and number of revolutions—which would not exceed 100—to obtain the effective thrust = to 18,000-horse power? And also, What pitch would such a screw have to drive the ship at forty knots? These and other questions await a satisfactory solution, and I confess they are beyond me. If Mr. Hurst or Mr. Paulson is dissatisfied with the case as I have here stated it, it remains for them to give a practical solution to the question, giving us weights and number of boilers, quality, weights, and dimensions of engines, and diameters and pitch of screws, &c. In conclusion, if they work this out, I think they will prove what I said at the first discussion of the subject—that "having placed their boilers, engines, and coal-bunkers, there will be no room left for seamen and other necessaries." ROBERT G. BLEASBY.

Marchmont-street, Russell-square,
W.C., May 14th.

COMPARISON OF LOCOMOTIVES, AUTOMOTORS, AND TRAM-CARS WORKED BY STORED-UP ENERGY.

SIR,—The mathematical reasoning, from the jurors' report on the Antwerp trials of mechanical traction for tramways, has a tendency to obscure the very point at the outset, which in the end it intends to prove, viz., the superiority of automotive or self-propelled cars over those drawn by separate locomotives. The report says:—"In calculating the weight Q of a locomotive which has to exert on the periphery of the driving wheel an effort E, the adhesion must, first of all, be taken into account. In fact, if a be the coefficient of adhesion in the case of a motor which is supposed to utilise the whole of its adhesion, the lower limit of the weight Q will be given by the formulæ."

$$E = a\,Q$$

$$Q = \frac{E}{a}.$$

This coefficient of adhesion, or in other words, the coefficient of friction between the driving wheels and the rails varies considerably, according to the kind and nature of the surfaces in contact. In dry weather the adhesion is much greater than in wet weather, when the rails and wheel tires are greasy; therefore we have to adopt in our calculations a low coefficient and provide much weight, in order to be able to work the locomotive safely at all times.

Again, the effort E on the periphery of the driving wheel should represent the initial force necessary to overcome the inertia of the locomotive and car. This initial force is found in practice to be about four times that of the tractive force when the vehicle is in motion. Consequently, if E and Q are of sufficient magnitude to insure the desired initial effect under the most unfavourable conditions, then the rest will follow as a matter of course. The term "specific energy" denoted by e is not a happy one, and the expression $e = \frac{E}{Q}$ is misleading. Tramway engineers speak of "the tractive force" in pounds per ton—or kilograms—which is nearly a constant quantity for a given load, and within the moderate speeds allowed for street traffic. This tractive force has been found to vary between 25 lb. and 30 lb. per ton on level dirty tram rails, with the car in motion; but 100 lb. to 120 lb. per ton is required to start the vehicle from rest. Experience seems to recommend about six tons as the safe weight for a steam locomotive hauling a two-horse tram-car on an average tram line in towns. Larger cars and heavier locomotives are used on some country lines.

The accompanying table gives the relative weights, the proportion of dead weight to passenger weight, the relative mechanical energy applied to the driving wheels to produce a given useful effect, and the relative cost of fuel for the following cases: (1) A separate steam locomotive hauling one car; (2) an electric automotive car carrying stored energy in secondary batteries; (3) an electric car deriving its energy through metallic conductors:—

	Separate locomotive.	Automotive car with stored up energy.	Electric car with conductors.
Weight of empty car in tons	2·0	2·0	2·0
Weight of forty passengers in tons.. ..	2·5	2·5	2·5
Weight of locomotive alone in tons.. ..	6·0		
Weight of accumulators in tons		1·25	
Weight of electric motor and gearing in tons		·75	·6
Total weight to be propelled in tons ..	10·5	6·5	5·1
Starting force in lbs.	1260	780	612
Tractive force of moving vehicle, lbs. ..	315	190	153
Proportion of dead weight to passenger weight	3·2 : 1	1·6 : 1	1·04 : 1
Relative mechanical energy applied to the driving wheels to produce a given useful effect..	2·05	1·24	1
Relative consumption of fuel if there were no losses in the electrical conversion and transmission	6·15	1·24	1
Relative consumption of fuel, assuming a loss of 50 per cent. in electrical conversion and transmission	3·07	1·24	1

If the tramway locomotive consumes on an average 7 lb. of fuel per mile whilst hauling a car with forty passengers at the rate of about seven miles an hour, we should have an expenditure of 49 lb. of fuel per hour. On the basis of the data which served for calculating this table, the tractive force—in motion—is 315 lb., which at a velocity of 616ft. per minute gives 5·87-horse power effective on the driving axles. The consumption of fuel is, therefore, 8·35 lb. per horse-power per hour. An economical stationary compound condensing steam engine of reasonable dimensions consumes not more than one-third this amount of fuel—of the same quality—consequently the relative cost for this item shows a vast difference when neglecting the losses attending the conversion of mechanical into electrical energy and *vice versâ*.

The loss arising in the transmission of electric energy in the case of conductors depends upon the size and length of such conductor, whereas with secondary batteries it is a constant known quantity. We have assumed, for the sake of argument, that this loss is 50 per cent. in both electric systems. We have thus a margin of 59 per cent. in favour of the automotive accumulator car, and 67 per cent. in that of the electric car with conductors. It is an easy matter to ascertain with the utmost accuracy the total efficiency of an electric apparatus, and thus modify the above figures accordingly, and our present object has been to render the comparison in a practical form. The efficiencies of dynamos, motors, and other apparatus would have to be very low indeed in order to bring the cost of fuel level with that of tramway locomotives.

The work of the jury at Antwerp, although not conclusive, has brought the subject of mechanical traction on tramways prominently before the world, and the results arrived at cannot fail to command attention. Perhaps some day more extensive and more searching tests may be instituted in this country, and these should include other systems, such as compressed air, fireless engines, gas motors, and cable traction, all of which deserve every encouragement. A. RECKENZAUN.

London, May 18th.

ON THE APPLICATION OF "BIDDER'S EARTHWORK TABLES" FOR HEIGHTS OTHER THAN WHOLE FEET.

SIR,—As many of your readers doubtless use "Bidder's Earthwork Tables" in estimating the quantities in cuttings and banks, the following note may prove of some interest and utility.

In applying Bidder's Tables there will necessarily be considerable inaccuracy should the nearest whole feet be taken for the end heights of cuttings and banks. Thus, if the end height for one lineal chain be 1·3ft. and 40·4ft., the exact content by the prismoidal formula for the two sloped portions, with 1 to 1 batters, is 1374·08 cubic yards; but if the nearest whole feet—*i.e.*, 1 and 40—be taken from the table (1337 cubic yards) there will be an error of 37 cubic yards; and likewise for the central trapezoid, an error of 0·87 cubic yards for each foot of formation width.

A nearer approach to accuracy is frequently adopted. This is to alter one of the end heights to the nearest whole foot, and to increase or diminish the other height by the amount of this alteration. Thus, in the example cited, the heights would be altered to either 1 and 40·7, or 1·7 and 40. Then the black and red numbers due 1 and 40 would be taken from the tables, and increased by $\frac{7}{10}$ths the difference between the numbers in the tables opposite 1 and 40 and 1 and 41, or by $\frac{7}{10}$ths the difference between the numbers opposite 1 and 40 and 2 and 40. This will be found to cause errors of + 9·72 and − 12·58 respectively for the slope number, but no error in the central trapezoid. The assumption here is that the volume increases in arithmetic ratio; this is true for the central trapezoid only.

The following method is proposed as being almost exact, and equally expeditious in working to the preceding:—

By the prismoidal formula volume of the 1 to 1 sloped portions in cubic yards $= V = \frac{22}{27}\left\{(H + H^1)^2 - H\,H^1\right\}$

H and H^1 in Bidder's tables being end heights in whole feet, let increments h and h^1, less than unity, be added to each; then

$$V = \frac{22}{27}\left\{(H + h + H^1 + h^1)^2 - (H + h)(H^1 + h^1)\right\}$$

and by expanding and arranging,

$$V = \underline{\frac{22}{27}\left\{(H + H^1)^2 - H H^1\right\}}$$

$$\underline{+ H \times \frac{22}{27}\left(2h + h^1\right) + H^1 \times \frac{22}{27}\left(2h^1 + h\right)}$$

$$\underline{+ \frac{22}{27}\left\{h^2 + h\,h^1 + h^{12}\right\}}$$

As h and h^1 have been taken less than unity, their squares and products are still less, so that the third and last underlined member of the equation can be neglected. The second underlined member of the equation will then represent the volume to be added for the increments h and h^1 to that found in Bidder's tables by taking the whole feet; and a table of the excess due to these increments can be formed by assigning values to h and h^1, increasing, say, by tenths of feet, and calculating the amount $\frac{22}{27}$ $(2h + h^1)$, as under:—

Table of Excess in Content of Slopes 1 *to* 1 *for Tenths of Feet.*

Height excesses in tenths.	0	·1	·2	·3	·4	·5	·6	·7	·8	·9
·1	·16	·24	·33	·41	·49	·57	·65	·73	·81	·90
·2	·33	·41	·49	·57	·65	·73	·81	·90	·98	1·06
·3	·49	·57	·65	·73	·81	·90	·98	1·06	1·14	1·22
·4	·65	·73	·81	·90	·98	1·06	1·14	1·22	1·30	1·38
·5	·81	·90	·98	1·06	1·14	1·22	1·30	1·38	1·47	1·55
·6	·98	1·06	1·14	1·22	1·30	1·38	1·47	1·55	1·63	1·71
·7	1·14	1·22	1·30	1·38	1·47	1·55	1·63	1·71	1·79	1·87
·8	1·30	1·38	1·47	1·55	1·63	1·71	1·79	1·87	1·96	2·04
·9	1·47	1·55	1·63	1·71	1·79	1·87	1·96	2·04	2·12	2·20

To apply the above table, find Bidder's slope number for end heights in whole feet, and having multiplied the whole feet in each height, taken separately by the number found in the table, at the intersection of its decimal in the vertical column and the decimal belonging to the other height in the top line, the three are to be added together. For example, with end heights of 1·3 and 40·4, Bidder's black number for 1 and 40 is 1337; then multiply the first height 1 by 0·81, the number at the intersection of 0·3 in the vertical column and 0·4; and 40 by 0·90, the number at the intersection of 0·4 in the vertical column, and 0·3 thus:—

$$1337 + 1 \times 0·81 + 40 \times 0·90 = 1373·81.$$

This differs by only one quarter of a cubic yard from the exact value.

The greatest error caused by neglecting squares and products of h and h^1 is when both have values of 0·9 $\frac{22}{27}$ [3 × ·81] = 2 cubic yards nearly; but this can be considerably reduced. For instance, if the heights were 1·9 and 40·8, find the slope number for 2 and 41 and deduct therefrom the quantity due to the difference between 0 9 and 0·8 with unity, that is, 0·1 and 0·2 thus:—

$$1440 - (2 \times 0·33 + 41 \times 0·91) = 1422·53,$$

giving almost no error, as against nearly two yards if 1 and 40, with decimals 0·9 and 0·8, were used.

The formula for the central trapezoid in yards is $V = \frac{11}{9}$ $[H + H^1]$; as before, add increments h and h^1 less than unity, then $V = \frac{11}{9}[H + H^1] + \frac{11}{9}\,[h + h^1]$, the following table gives values for the last member, h and h^1 increasing by tenths of feet.

Table in Excess in Content of Central Trapezoid for Tenths of Feet.

Height excesses in tenths.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
·1	·1	·2								
·2	·2	·4	·5							
·3	·4	·5	·6	·7						
·4	·5	·6	·7	·8	1 0					
·5	·6	·7	·8	1·0	1·1	1·2				
·6	·7	·8	1·0	1·1	1·2	1·3	1·5			
·7	·8	1·0	1·1	1·2	1·3	1·5	1·6	1·7		
·8	1·0	1·1	1·2	1·3	1·5	1·6	1·7	1·8	1·9	
·9	1·1	1·2	1·3	1·5	1·6	1·7	1·8	1·9	2·1	2·2

To use this table, find Bidder's red number for end heights in whole feet; add the number found at the intersection of the decimals; thus with 1·3 and 40·4 ÷ − 50·1 + 0·8 = 50·9.

May 18th. C. E. Q.

PILE DRIVING.

SIR,—I am obliged to "Scrutator" for pointing out that the 72,000 means tons not pounds, and admit that I ought to have ascertained this by actual evaluation of the formulæ. I have solved the problem by a totally different method, and find that the formula stated by "Scrutator" gives the correct maximum pressure when there is no penetration; although the maximum pressure is double the statical load which would produce the same degree of compression if applied at once but without initial momentum. By the method I have adopted, I have obtained a formulæ which gives the maximum pressures for all degrees of penetration. Engineers must feel very much obliged to Mr. Nicolson for attempting the solution of the problem in the Cambridge examination paper. I think, however, I shall be able to convince Mr. Nicolson that his solution is erroneous, and that engineers may be pardoned if they come to the conclusion that some modern mathematicians do not digest very carefully the matter they send to the public press.

If a perfectly inelastic body of mass $\frac{W}{g}$ moving with a velocity V strikes another perfectly inelastic body of mass $\frac{w}{g}$, *free to move in the direction of impact*, then if that direction passes through the centre of gravity of the body at rest, the two bodies will move after impact in the same direction with a common velocity V given by the equation of relation $v\,(W + w) = V\,W$, as stated by Mr. Nicolson. The pile, however, is not free to move, and the common velocity of pile and monkey, when the latter is brought to rest, cannot exceed the velocity of penetration at that instant. Whether or not this velocity is zero at the same instant will depend entirely on the nature of the resistance offered to the bruising. In any case, since the common velocity of the pile and the monkey, according to Mr. Nicolson's own statement, must have been gradually acquired, some of the penetration must have been produced during this interval, and therefore the whole work of penetration cannot be equal, as stated by Mr. Nicolson, to the work stored up in the pile and the monkey at the instant the velocity of the monkey relative to the pile becomes zero.

If Mr. Nicolson's proof were correct, we should, in fact, be able to calculate the penetration of the pile at the instant the relative velocity of the monkey and the pile becomes zero from the observed extent of the bruising. In strict accordance with Mr. Nicolson's own statement, the velocity v of the pile must have been gradually acquired, and therefore the pile must in the interval $\frac{x}{V}$ have moved through a space $= \frac{x}{V} \times \frac{v}{2} = \frac{v\,x}{2\,V}$. In accordance, then, with Mr. Nicolson's calculations, penetration must necessarily in all cases take place during this interval. Also, since the work expended in producing the penetration $\frac{v\,x}{2\,V}$ is equal to the work stored up in the monkey at the instant of impact minus the work stored up in both monkey and pile, when the relative velocity is zero, viz.,

$$\left(W - \frac{W^2}{W + w}\right)\frac{V^2}{2g} = \frac{W\,w}{W + w}\cdot\frac{V^2}{2g};$$

it follows that when the resistance of the earth is uniform, the total penetration of the pile must be equal to—

$$\frac{v\,x}{2\,V}\left(1 + \frac{w}{W + w}\right) = \frac{W\,x}{W + w}\left(1 + \frac{w}{W + w}\right),$$

which must be less than x unless the factor by which it is multiplied is equal to or greater than unity *i.e*, unless $w = o$. *A fortiori*, when the resistance of the pile varies with the penetration, that penetration must always be less than the extent of the bruising. WILLIAM DONALDSON.

2, Westminster-chambers, London,
May 19th.

[We can insert no more letters on this subject.—ED. E.]

THE BLACKPOOL ELECTRIC TRAMWAY.

SIR,—My attention has only now been called to the letters in your issues of the 30th ult. and 7th inst. *re* the "Blackpool Electric Tramway," and I beg to thank the writer of the first for his able criticism and many suggestions. If he will favour me with his name and address, I shall be glad to show him how in the spring of last year I designed and patented methods of carrying out the ideas he mentions so far as they are applicable. I also wish to thank the writer of the second letter, and to confirm his remark respecting "rigid attachments" of the "collectors" to the cars. I tried them in my first experiments, and they failed. I will not say it is impossible to use a rigid attachment, but I can assure the "Borough Surveyor" that one of the secrets of success is a flexible collector flexibly attached. M. HOLROYD SMITH.

Halifax, May 11th.

THE CONSTRUCTION OF QUAY WALLS AT ROTTERDAM.*

By H. A. VAN YSSELSTEYN.

THE increase in the shipping at Rotterdam made extension of quay-room necessary. In 1852 a beginning was made in widening the Boompjes quays by building a wall in front of the then existing one. For the sake of economy, the usual pile foundation was dispensed with and instead of it a rubble-mound of basalt was made up to low-water level, and a brick wall erected on this at a cost of £8166 for a length of 750 metres. The work was situate on the concave side of the river bend, and rested on a stratum of about 16 metres thickness of bog; before it was completed a length of 70 metres slipped into the river. The repaired piece was built on a pile foundation which, however, could not be driven to satisfaction through the remains of the former riprap mound. The whole of this work continued to settle and lean outwards, till in 1882, when part of it fell over, a beginning was made with the total renewal. This new wall stands from 7 to 16 metres in advance of the old one on a continuous pile-foundation. The piles are driven through the slope of the existing rubble mound which prevents under-scour. The floor, supported on piles 1 metre apart centre to centre, is from 10 to 18 metres wide, lies 70 centimetres—2ft. 4in.—below mean-water level, and carries on its outer edge the quay wall. The great depth of water just outside the new work precluded the use of a coffer-dam, and a sort of diving-bell was resorted to for the construction of the timber floor and foot-courses of the wall. The bell is a rectangular box of wrought iron, 44ft. by 22ft. in the clear inside, and a clear height of 7ft. 8in. The walls are double, the web-plates being 16in. apart. The weight of the bell itself is 70 tons, and ballasted with 116 tons, or together about equal to the weight of the water displaced at a draught of 4ft. When a greater submergence is required the double sides are filled with water ballast to an additional weight of 32 tons, and tanks placed on the top can contain another 118 tons of water.

The air pumps are driven by a 5-horse power portable engine fixed on shore, and coupled to the bell by means of cast iron pipes and india-rubber hose. The ballast tanks are filled from the service-hydrants of the town supply. The work for which the bell is intended is: first, the clearing away of the old work below low-water level; secondly, the fixing of the timber floor over the piles after these are driven, and the laying of the lower courses of the wall.

After the old work has been cleared away down to low-water level the caisson is floated light over the desired spot, then grounded by allowing some air to escape, at the same time filling the water ballast tanks; after grounding air is forced in again before the men enter. Although air-locks are provided for taking materials in and out, these are seldom used; timbers and other objects are mostly brought in by passing them in under the sides. The bell was made by John Cockerill and Co., of Seraing, for £2500. The walls now under construction consist of columnar basalt in Portland-cement mortar up to mean high-water level. Above this the facing is of basalt with a backing in brickwork. The average cost per lineal metre is 650 florins—about £48 per yard.

* "Proceedings" Inst. Civil Eng. from "Tijdschrift van het Koninklijk Instituut van Ingenieurs."

REFRIGERATING AND ICE-MAKING MACHINERY.

For description see page 394,)

FIG. 1.

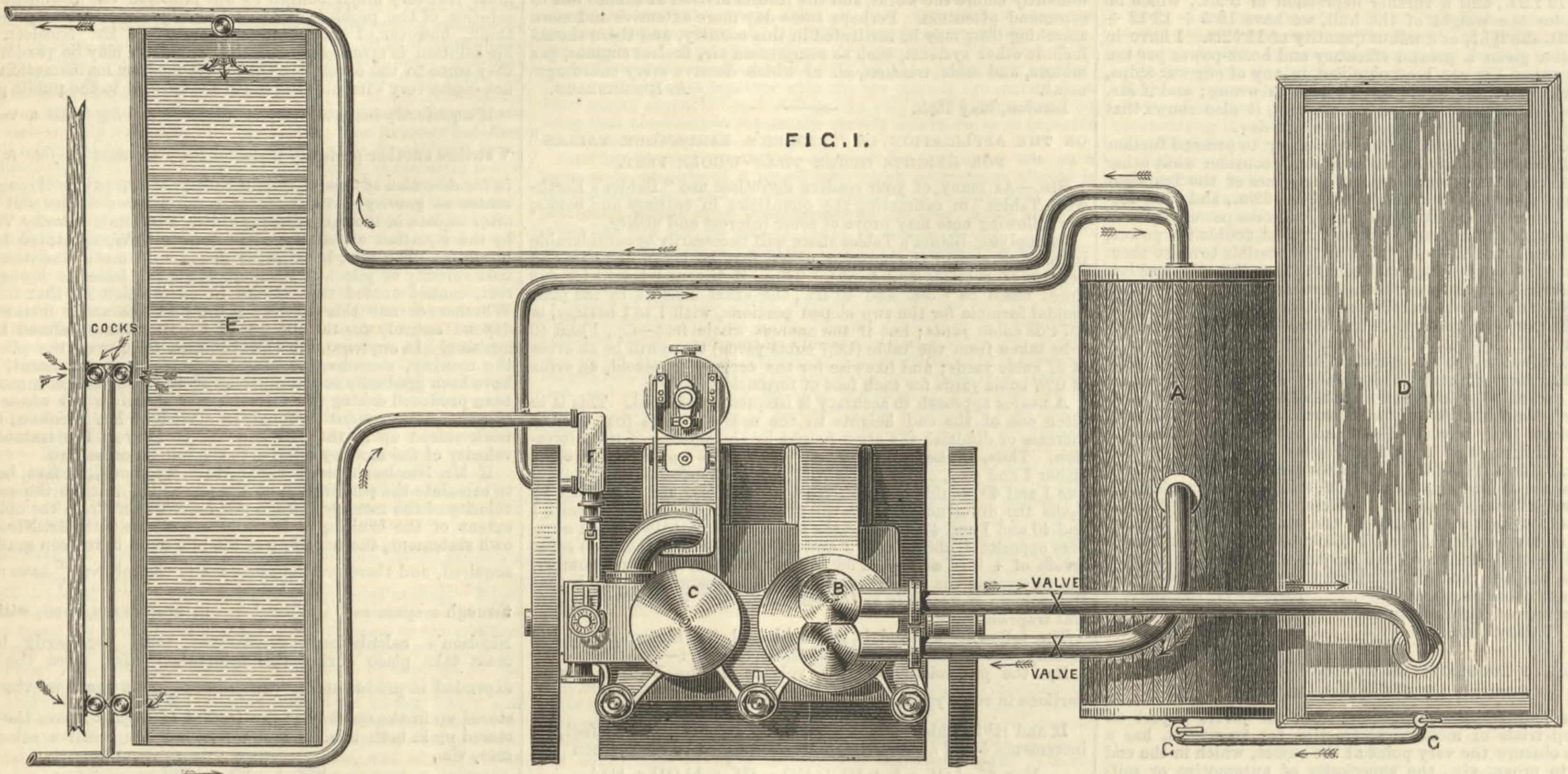


FIG. 2.

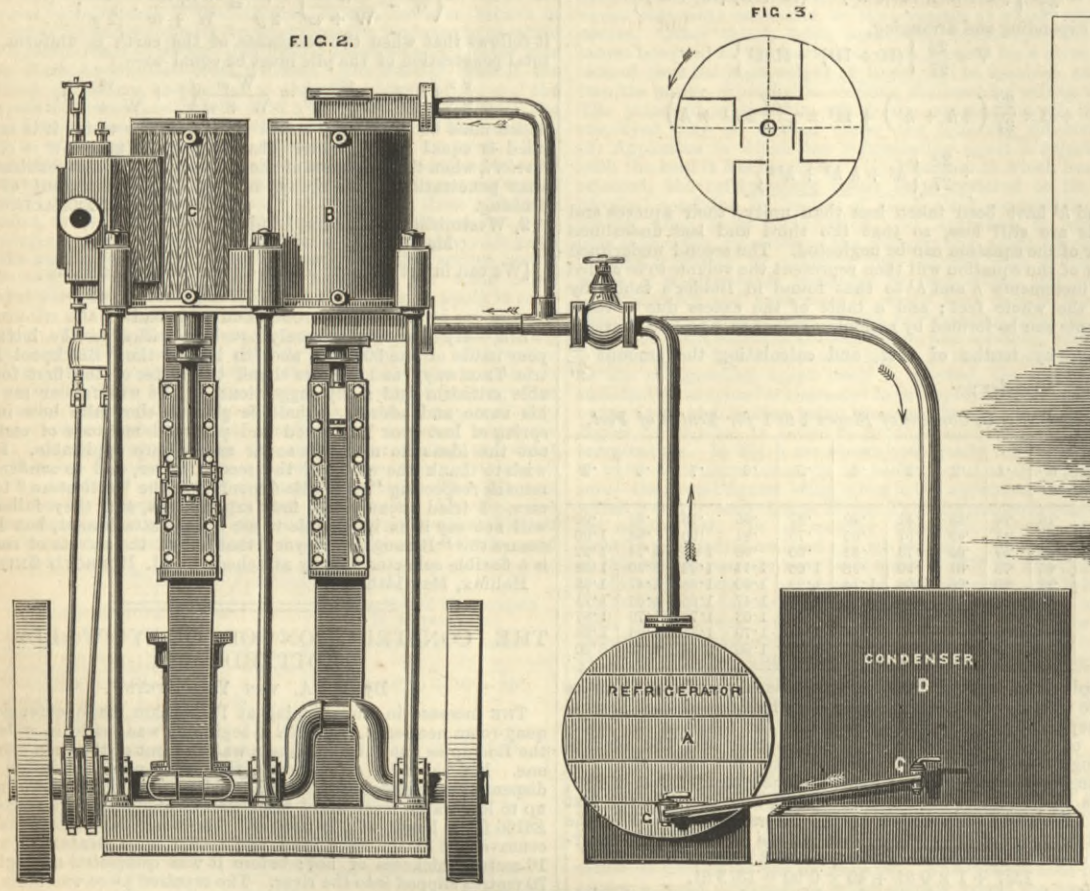


FIG. 3.

FIG. 4.

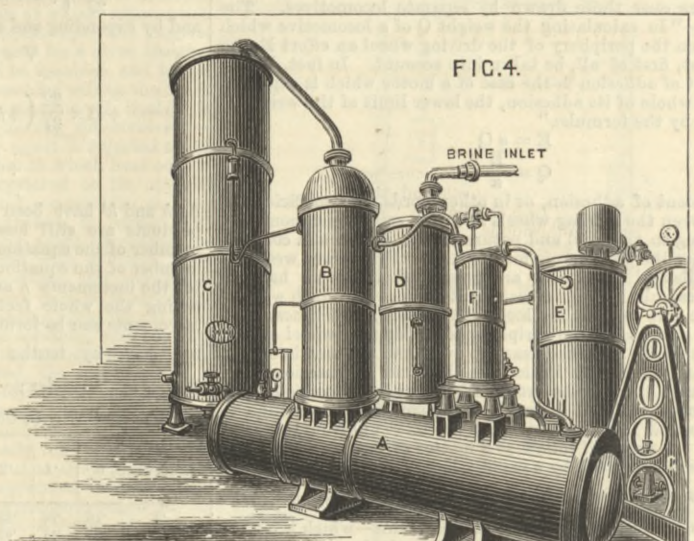


FIG. 5.

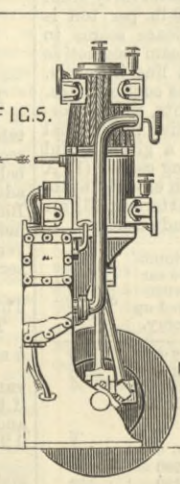


FIG. 6.

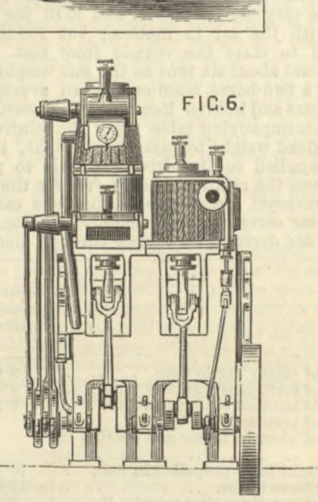


FIG. 9

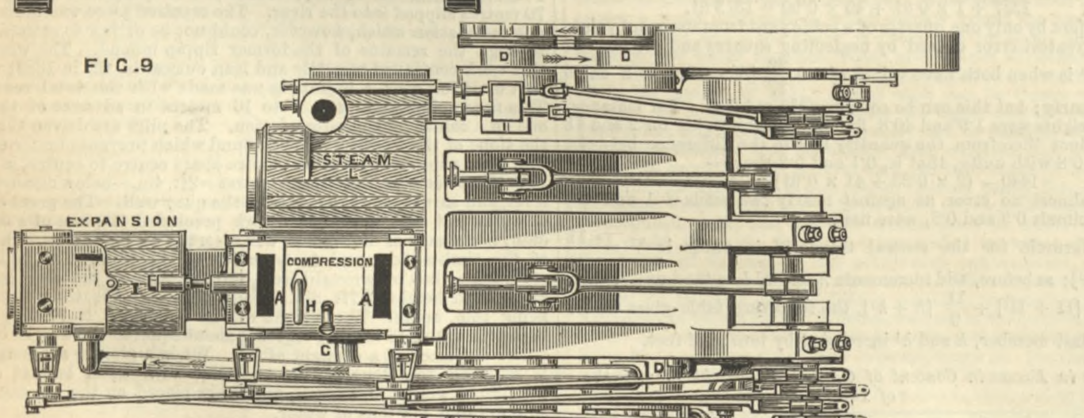


FIG. 7.

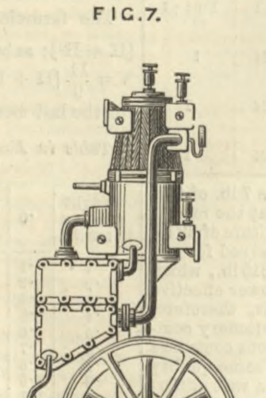


FIG. 8.

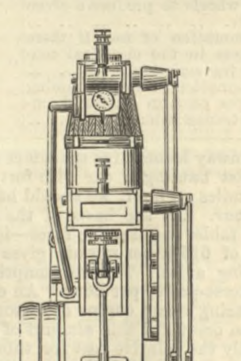
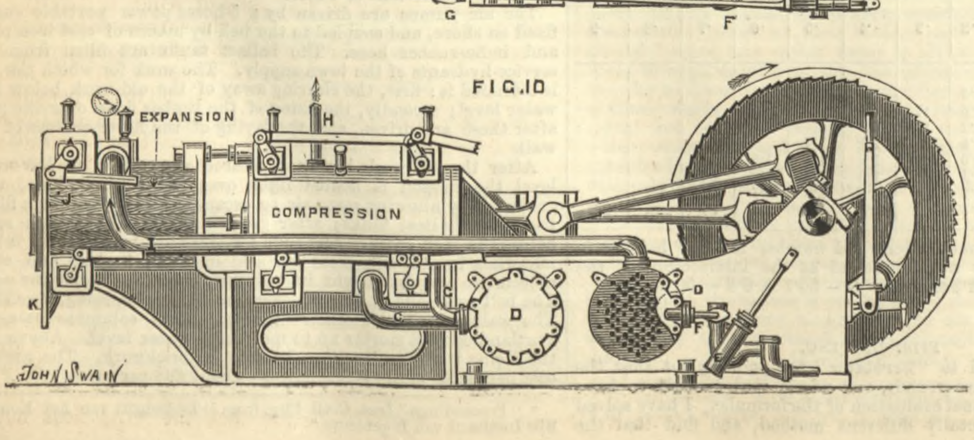


FIG. 10



FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

PARIS.—Madame Boyveau, *Rue de la Banque.*
BERLIN.—Asher and Co., 5, *Unter den Linden.*
VIENNA.—Messrs. Gerold and Co., *Booksellers.*
LEIPSIC.—A. Twietmeyer, *Bookseller.*
NEW YORK.—The Willmer and Rogers News Company, 31, *Beekman-street.*

CONTENTS.

The Engineer, May 21st, 1886.

	PAGE
Admiralty Coefficients	387
The Edinburgh International Exhibition. No. II.	388
Iron and Steel Institute	389
The Westinghouse Brake	389
Tenders	390
Railway Matters—Notes and Memoranda—Miscellanea	391
The Birmingham Gasworks. (Illustrated.)	393
Refrigerating and Ice-making Machinery and Appliances. (Illus.)	394
Letters to the Editor—Bulkhead and Bulkhead Doors—Forty-knot Speed Ships	394
Locomotives, Automotors, and Tram-cars Worked by Stored-up Energy—On the Application of "Bidder's Earthwork Tables"—Pile-driving—The Blackpool Electric Tramway	395
The Construction of Quay Walls at Rotterdam	395
Leading Articles—Our Coaling Stations—Tornadoes	397
The Dismasting of Sailing Ships—An Engineering Degree	398
South Durham Salt Borings—Foreign Competition—Proposed Railways in Burmah and Siam—The Institution of Civil Engineers	399
Literature	399
Water Softener and Purifier. (Illustrated.)	400
North-East Coast Institution of Engineers and Shipbuilders	400
The Trent Gas Engine. (Illustrated.)	401
The Brighton Electric Railway	401
The Tramways of Liverpool. (Illustrated.)	402
The Professor in the Machine Shop	402
Method of Stating Results of Water Analysis	403
American Notes	403
The Iron, Coal, and General Trades of Birmingham, Wolverhampton, and other Districts	403
Notes from Lancashire	403
Notes from Sheffield	404
Notes from the North of England	404
Notes from Scotland	404
Notes from Wales and Adjoining Counties	404
New Companies	405
Experimental Works for Improving the Fairway of the River Don	405
The Patent Journal	405
Selected American Patents	406

Paragraphs—Launch of a Screw Steamer, 390—The Regulation of Railways Act, 390—The Millers' Convention in Dublin, 400—The British Association, 400—Civil and Mechanical Engineers' Society, 403—The Panama Canal, 403—The Severn Tunnel, 403—King's College Engineering Society, 405.

TO CORRESPONDENTS.

Registered Telegraphic Address—"ENGINEER NEWSPAPER, LONDON."

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

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

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

F. W. P.—*The book is not, we think, sold. Write Mr. Waddell, Tokio.*

A Machinist.—*Thanks for your letter. We shall consider your suggestion.*

G. F.—*The question of providing a sufficient number of seaworthy ships' boats rests with the Board of Trade. The publication of your letter would be mere waste of space.*

Friction.—*There is no trustworthy information available concerning the loss by friction in screw gearing. It is generally put down at 30 per cent., but we believe that this estimate is far too high.*

Lancastrian.—*We cannot answer your question without further particulars. Are your cranks to be at right angles or not? Meanwhile we beg to refer you to Mr. Cole's paper read before the Institution of Naval Architects, an abstract of which you will find in* The Engineer, *page* 334.

Collier.—*You have omitted the most important information. Whereabouts in the stroke do the engines stick? It is also desirable that we should know something of the way in which the engines drive their load. Is the crank shaft geared to the barrel? Is there a link reversing motion? Give full particulars, and we will endeavour to advise you.*

A Waterside Crane.—*You should complain to the makers of the valves. There is reason to believe that the wearing surfaces are too small. A lubricator might be used of the kind fitted with a screw and a piston, so that the oil would be forced down on the face. We should advise you to make trial first of a mixture of blacklead and tallow, worked up into an ointment, and smeared on the valve face. Try this and let us know the result. Use about half and half by weight blacklead and tallow. The blacklead used for cleaning stoves will answer.*

TEMPERING DIES.

(*To the Editor of The Engineer.*)

Sir,—I shall feel very grateful if any of your readers can help me in the following matter:—I have lately had occasion to temper a number of dies for punching with, also a few milling cutters; and I find, notwithstanding the greatest care in heating them, both in forging and tempering they are very liable to become cracked in the tempering, and to put them in oil does not make them hard enough for the purpose I require them. If any of your readers could tell me how to prevent this, or the name of any book that would be of use, they will greatly oblige a

Glasgow, May 13th. Blacksmith.

SUBSCRIPTIONS.

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

Half-yearly (including double numbers) .. .. .. £0 14*s.* 6*d.*
Yearly (including two double numbers) .. .. .. £1 9*s.* 0*d.*

If credit occur, an extra charge of two shillings and sixpence per annum will be made. The Engineer *is registered for transmission abroad.*

Cloth cases for binding The Engineer *Volume, price* 2*s.* 6*d. each.*

A complete set of The Engineer *can be had on application.*

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

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

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

MEETINGS NEXT WEEK.

The Institution of Civil Engineers, 25, Great George-street, Westminster, S.W.—Tuesday, May 25th, at 8 p.m.: Annual general meeting. To consider the report of the Council on the state of the Institution, and to elect a President and Council, and to appoint auditors for the session 1886-87.

Society of Telegraph Engineers and Electricians, 25, Great George-street, S.W.—Thursday, May 27th, at 8 p.m.: Papers to be read, "The Telephone as a Receiving Instrument in Military Telegraphy," by Captain P. Cardew, R.E., Member. "On a Problem Relating to the Economical Electrolytic Deposition of Copper," by Captain H. R. Sankey, R.E., Member.

Society of Arts, John-street, Adelphi, London, W.C.—Monday, May 24th, at 8 p.m.: Cantor Lectures. "Animal Mechanics," by Mr. B. W. Richardson, M.A., M.D., F.R.S. Lecture III.—Some special mechanisms—the animal camera. Tuesday, May 25th, at 8 p.m.: Foreign and Colonial Section. "Cyprus Since the British Occupation," by Mr. G. Gordon Hake. Major-General Sir Robert Biddulph, K.C.M.G., C.B., will preside.

DEATHS.

On the 13th inst., at 191, Camberwell New-road, John Gordon McKenzie, C.E., aged 67.

On Sunday, the 16th inst., at Bournemouth, William Fothergill Batho, C.E., of Timperley, Avenue Elmers, Surbiton, aged 58 years. Friends will kindly accept this—the only—intimation.

THE ENGINEER.

MAY 21, 1886.

OUR COALING STATIONS.

We were, we believe, the first to call attention to the imperfect condition of defence in which the coaling stations in our colonies are left. Our statements so made were not long in finding support from other quarters, and the result has been, as our readers are aware, that practical steps have been taken to give effect to the recommendations we then advanced. There has hitherto been apparently a unanimous acquiescence both by our colonists and those interested who are resident in this country, in the resolutions which were taken on this subject, and we are the more surprised therefore to find that so eminent an authority as Sir E. J. Reed has but lately thought proper to cast a doubt upon their propriety and on the advisability of proceeding further with the works of defence which are, in some cases, already considerably advanced. A question was put in the House of Commons only lately relative to the progress which has been made in this direction, and during the discussion which ensued, Sir E. J. Reed took what appears to us to be the extraordinary step of condemning any further expenditure. We may with advantage consider the grounds upon which a gentleman, whose opinions upon all matters relating to naval concerns are entitled to so much weight as are Sir E. J. Reed's, deemed it desirable to express such condemnation.

The question of providing adequate means of defence for those stations upon which the supply of coal to our various squadrons must in time of war be dependent, has long been before the public. It has been discussed many times over, both in the columns of the public press, by our professional and scientific societies, and in the Houses of our Legislature. We cannot call to mind that on any of these occasions there has been found anyone to cast a doubt upon the necessities which our great Imperial responsibilities have cast upon us. But at the eleventh hour, when much money has been spent and much progress made towards the end which all have united in considering desirable of attainment, we have an authority of the standing of Sir E. J. Reed pronouncing that the whole of the proceeding has been, and is, a mistake! We confess that we cannot see that the grounds stated by that gentleman for such an opinion are in any way tenable. He has asserted that long before the defence works in progress or in contemplation at our coaling stations are complete, the use of coal as a fuel will have become obsolete—that it will, in fact, have been superseded by the employment of liquid fuels, and that therefore defences for the object named will be useless. We can find no justification for such an argument. Let the fuel of the future for our steamships be what it will—and we are not now concerned to support or refute Sir E. J. Reed's prophecy on this point—it is certain that stores of it must be provided at numerous places. We assume that the late Naval Constructor considers that our ships will be able, should liquid fuel be finally adopted by them in lieu of coal, to carry a sufficient quantity to enable them to make through journeys, without calling in to fill up as at present. Such a position is not fully obvious even as regards the passages of mail, or even purely mercantile steamers; but neither with this point need we at present concern ourselves. It is as regards our fighting ships in commission in distant quarters of the globe during a time of war that we have to consider this question.

We will suppose that, under such conditions, a superior or even only equal, force of a hostile Power is contesting with ourselves the seas in which our fuel supply ports are situated. The scattered dominions of our colonial empire, and the necessities of defence they impose, must altogether prevent any admiral from keeping his ships together as a united fleet. To fulfil the services demanded of him he must detach vessels singly or by twos or threes. What guarantee is there that an enemy shall not be in superior force at intermediate points, and be able to stop the resort of isolated cruisers to a particular fuel port? There would, under such circumstances, be no help for it but to extend the journey to some port still further distant. How can we be certain that even the resources of stowage for liquid fuel will not become exhausted before the lengthened journey can be accomplished? This is but one of the many contingencies apparent under which even the power of carrying a sufficient supply of that material may prove to be inadequate. Space does not admit of our considering all such possible contingencies, but we think it must be evident to thinking men that we can look forward to no period at which, during time of war, it will be possible for our steamers to keep the seas without resorting to ports to fill up with fuel. Hence there must be such ports, and that necessity admitted, it equally follows, from all that has been spoken and written on the subject during the past few years, that they must be defended.

We may set aside the question which might be raised on Sir E. J. Reed's argument as to whether the number of our coaling stations may be safely reduced; but it is impossible to help seeing that during the exigencies of warfare the more of such places of resort that are available the greater will be the strategic advantage possessed by an admiral who has to direct the movements of our fleets, or detached squadrons or vessels. The more we consider Sir E. J. Reed's argument the more illogical we deem it to be. Granted that liquid fuel is more readily transferrable from one ship to another than is coal, who can be sure that a vessel able to afford a supply can always be met with? They must always be met with at determinate points, and whatever may be the nature of the fuel, those points of rendezvous must be defended. From such a conclusion there can be no escape, and we have besides to deal with facts as they exist, and not upon problematical assumptions such as that put forth by the member for Cardiff.

TORNADOES.

Tornadoes, or, to speak more accurately, whirlwinds, have within the last few weeks exerted their peculiar powers with unusual violence. Full particulars of the destruction wrought by one in Spain are only now reaching this country. In the United States it is held that the tornado which on the 14th of April ravaged the districts of St. Cloud and Sauk Rapids in Minnesota, was the most violent on record. It is thus described by Mr. H. C. Hovey, who being at some little distance from its path, saw what took place, escaping unharmed:—"During the day a remarkably high temperature had prevailed for the season, the mercury rising as high as 80 deg., and the air was sultry and oppressive. At three p.m. observers saw dark banks of struggling clouds overhanging the ridge that in ancient times used to be the river limit, and there were apprehensions of impending danger. Suddenly the clouds began to revolve, while sharp points shot downward, until a whirling funnel-shaped mass was formed above a basin amid the hills that seems to have furnished the cradle for the ensuing tornado. Its first condition was undoubtedly that of a simple whirlwind, having a diameter of about 1000ft., which uprooted or twisted off nearly every tree in its circle, overturned the monuments in the adjoining Masonic cemetery, and tore up the boulders from the ground. Thence it moved slowly and majestically along, at the rate of about twelve or fifteen miles an hour, but with an inconceivably rapid rotary motion upon its vertical axis, confining itself for some distance to a path hardly more than 150ft. wide. The pyrotechnic display of flaming colours against a background of sooty blackness was very impressive and wonderful. Hundreds of people took timely warning and got out of the road of the moving column of cloud, whose general trend was towards the north-east. Having wrecked the Catholic church on Calvary Hill, and also several farmhouses, it entered a portion of the city of St. Cloud mainly occupied by foreigners, whose frame cottages were strewn over the plain indiscriminately, leaving nothing but the cellars to mark the site of the houses."

Mr. Hovey goes on to describe at considerable length the havoc wrought by the whirlwind in its course. "Putting together the testimony of various observers stationed at different points, the width of the tornado's track must have varied from 100ft. to 1000ft.; its entire duration must have been rather less than one hour, lingering but a few moments in any one locality; and the entire distance traversed by it, from the starting point south-east of St. Cloud to the point where it burst in a heavy rainfall, considerably north-east of Rice's station, was about thirty-five or forty miles. The total loss of life thus far reported from all points was about ninety individuals, and about twice that number injured. The sum total of property destroyed could not have been less than £80,000." Such storms are by no means rare. Lieutenant Finley, indeed, has written a book entitled "Six Hundred Tornadoes," and giving more or less precise accounts of each. It is not too much to say, however, that no explanation worth the name has ever been given of their cause; and there is little reason to doubt that a great deal of misapprehension exists concerning them. The received idea is that a volume of air has a violent whirling motion imparted to it, and that the wind thus produced does all the mischief. This appears to us to be very inconsequent reasoning. We all know that a volume of air left to itself has no power of movement whatever. It is certain, therefore, that some external cause, force, or influence must operate on the atmosphere in order to set it in motion. Why should this force operate only on the air, and not on other natural objects? Let us pause and endeavour to ascertain what this force is *not*. This is the very first step to be taken in clearing the way to an inquiry intended to settle what the cause *is*—a point, however, concerning which we may say at the outset we have no positive information of any kind to make known.

The ordinary theory of the cause of winds is that they are due to differences of pressure in the various parts of the great atmospheric sea surrounding this globe to a depth of many miles. These differences of pressure are brought about by expansion due to the sun's heat, and to the presence or absence of aqueous vapour in the air. Thus a column of air saturated with moisture is lighter than a similar column of dry air. When saturation takes place in a given locality the barometer falls, and air rushes in from all sides to equalise the pressure, and we have as a result winds. This is a very pretty theory, and no doubt it does account for gentle breezes, and even for moderate winds. But it totally fails to explain more violent atmospheric disturbances. Let us say that in a large district, with Staffordshire for its centre, the barometer stands at 29in., while in a district surrounding Paris it stands at 31in. The air should then blow from Paris towards Staffordshire. Now we have only to look at any meteorological chart with isobars laid down on it, to see that the wind does not invariably blow from the high to the low barometer. It sometimes does the very reverse. But putting this on one side, we know that violent winds occur, the rapidity of movement of which cannot be explained by the difference in heights of the two barometers. Storms blow when the difference of pressure in two places cannot exceed 1in. of mercury, or, say, half a pound on the square inch; and bearing in mind that there is no such thing as a strict line of demarcation between high-pressure and low-pressure area, it is very difficult to see how this can explain the rapid motion acquired by the air. The variation in barometric heights again is entirely incompetent to account for gusts. We are all familiar with the fact that the speed of the wind on some days is very constant, while on others it is very variable. At one moment it will fall almost flat calm, at another it rattles our doors and windows, and sets our slates flying. Has any one of our readers asked himself why the wind blows in gusts? In some places, notably on the coast of Florida, the wind will blow with absolute steadiness every day for months in one direction. We have all heard of the land breeze and the sea breeze of tropical climates, which are quite steady and due to very small differences of pressure caused by the heating action of the sun during the day and the withdrawal of that action at night. But there are winds of all kinds, steady and unsteady. The height of the barometer, again, can have nothing to do with squalls. In calm weather a little cloud will arise, and come down borne on a small mass of air moving at a great velocity; and woe betide the ship caught unprepared by a "white squall." The path of these squalls is narrow. No one knows where they come from or go to. Their existence at all is enough, we think, to prove that simple differences of pressure—"gradients," as the meteorologists call them—will not account for all the movements of the atmosphere; and yet science knows nothing precisely of any other cause that can put air in motion, save a difference of pressure in two portions of the atmospheric sea. How can differences of pressure explain the fact that there is no recorded instance of a cyclone crossing the equator, or for the fact that cyclones always rotate contrary to the movement of the sun? Thus in the Northern Hemisphere the course of the sun is from the east, by south, west, and north; and the movement of the storm is from north, by west, south, and east. In the Southern Hemisphere the movement of the sun being from east, by north, west, and south; that of the storm wind is from north, by east, south, and west. Thus north of the equator they turn contrary to the hands of a watch; south of the equator, with the hands of a watch. We say that nothing is understood concerning the cause of all this, knowing that "electrical disturbances," to use a familiar jargon, are said to cause tornadoes or whirlwinds; but this is mere assumption, and science has no evidence available to prove that electricity does cause tornadoes. It is quite true that lightning and thunder usually accompany them, and so does rain. No one has said that the rain is a cause, and there is no more reason for believing that electricity is a cause. It is just as obvious that it is an effect; and it appears that a precisely similar mistake is made when men assure us that the violence of the wind tears down houses, uproots trees, empties the beds of rivers, and so on. There can be no question that a great mass of air is set in violent rotation, but we also know that the cause of this rotatory motion must continue to act, or the air would soon come to rest. Its own momentum would not suffice to keep it going for many seconds. Indeed, this peculiar force must be constantly exerted to produce centripetal action. Let it cease for a moment and centrifugal force would dissipate the tornado instantaneously. Now is it not absurd to suppose that this force, whatever it may be, is so discriminating that it will act on air alone, and on nothing else, and that all the mischief done is due to the violence of the wind, and to it alone? To us this appears a doubtful deduction. No doubt the wind does act with extreme violence, but it is quite possible in one sense that if no air at all existed houses might be snatched up, trees torn up by the roots, and fearful destruction wrought. We have to do in a word with vortex motion and its laws, and the action which takes place is really quite different from that which is present when a wind blows straight on end, as sailors say.

Let us indulge in the wild hypothesis that a violent disturbance of the ether assumes the vortex character. We shall be told that the ether, being imponderable, cannot act on material substances like trees and men, and therefore cannot whirl them round and round. Yet air is a material substance, and we have yet to learn that the ether can pick and choose what it will act on. Therefore it may, we think, be taken for granted that it is not the air alone that does mischief in a tornado, but that trees, houses, and men are exposed to the action of the same mysterious force that operates upon the atmosphere. The tornado, or whirlwind, and the cyclone are alike manifestations of that astounding and mysterious agency which constantly tends to make matter move in circles. We see it in the whirl of the planets round the sun, in the steam rings from an exhaust pipe, in the drop of coloured water descending through a clear fluid. The ancient Egyptians were said to use a coiled snake with his tail in his mouth as the emblem of eternity. Is it not more likely that they employed it to denote their cognition of that mighty law of rotation which pervades all space and all time. When the cause of this law has been determined, nature will have few secrets left undisclosed.

THE DISMASTING OF SAILING SHIPS.

THE frequency with which, during recent years, serious damage has been sustained by the masts and spars of iron and steel sailing ships is a subject calling for careful attention on the part of shipowners, shipbuilders, and underwriters. Cases of dismasting are becoming matters of common occurrence, and to such an extent is this form of casualty being experienced that comparatively little notice is now being taken of it. Unless the subject is speedily taken under serious consideration there will be a danger of dismasting being looked upon as almost a matter of course, rather than a comparatively avoidable class of disaster. If loss of property were the only consequence of loss of masts and spars, the case would be sufficiently serious; but when it is remembered that human life is sometimes sacrificed through the same cause, it surely behoves all concerned to seek for the reasons which shall explain the greater frequency than formerly of cases of dismasting.

The great increase in the number of mercantile vessels afloat which occurred between the years 1879 and 1883 will, of course, account to some extent for a greater frequency of casualties upon the seas of all kinds. But then that increase did not consist of sailing vessels, but of steamers. The sailing tonnage of the country steadily diminished during many years, and although the rate of diminution has recently received a check, it is only reasonable to suppose that with the first revival of trade, steam tonnage will recommence to displace sailing tonnage at the same rate as before. During the last year or two an impetus has been given to the building of sailing ships as compared with steamers; simply because in dull times like the present a sailing ship can just make a profit while a steamer would work at a loss. This is largely due to the preference shown by merchants for sailing ships, because of the fluctuations in value which a cargo may undergo during the period of transit. But although the production of sailing ships has thus received a little encouragement, the tonnage built has not much if at all exceeded that lost during the same time. Nor is it probable that the number of sailing ships has been increased, for the new vessels average a larger tonnage than those which have disappeared. The frequency of dismasting accidents cannot therefore be explained by a greater number of sailing ships being afloat. The cause must be sought elsewhere. Now there are four conditions which may be advantageously inquired into in order to discover the cause of a vessel being dismasted, viz.:—(1) The stowage, and therefore the stability of the vessel; (2) the strength of the masts and spars; (3) the materials and arrangements of the rigging; (4) the skill of the seamen in charge.

It is to be feared that in these days of hurry and quick despatch as much care is not taken in loading as formerly, when more time was given for getting the cargo into a vessel. The stevedore has now-a-days very often to work from hand to mouth, without knowing either what is to go into the ship or when it will come alongside her. He has often to put the cargo into the hold in the order in which it arrives, without due regard to the requirements for proper stability and easy sea-going qualities. Hurry is the curse of the second half of the nineteenth century, and, unfortunately, the tendency of keen competition seems to be in the direction of still less painstaking care in loading ships, as in other and less important matters.

There are no reasons for supposing that the iron and steel lower masts of modern sailing ships are, when honestly made, less strong than the wood ones which were formerly in use, or than the iron masts of a few years ago. When new, the built wooden masts put into large ships were undoubtedly very strong; but then they were liable to decay, and from that species of danger an iron or steel mast is exempt. Dismasting was at one time often traceable to decay of the masts; but that cause may now be set aside. The scantlings for iron lower masts now in vogue are doubtless sufficient, but that the masts may be trustworthy the work in them must be sound. It is very much to be feared that the modern practice of fitting butt straps on the outside of the mast, although structurally desirable, yet offers an inducement to neglect fitting the butts with the same care as was taken when the straps were on the inside of the mast, and the butts, therefore, always visible. Working by the piece, too, leads to unsatisfactory results, especially in regard to the soundness of welds in the smith's work. A flaw or defective weld in an eye bolt or shackle, which no inspection, however minute, could detect, may lead to the entire dismasting of a ship. How important, then, is it that such work should be carefully done by a conscientious and skilful workman, who is influenced by no inducement to hurry through and scamp the job. The sizes of plates and angle bars usually employed in the construction of iron and steel lower masts are sufficient for the production of spars much stronger and far more durable than were used by our grandfathers; but yet our ships get dismasted with a frequency such as has hitherto been unknown. It is doubtful whether any reasonable increase in the scantlings will meet the case. What we want is honest workmanship, and to secure that there should be no inducement offered to the workman for hurrying through his work, and thereby doing it badly. This is especially the case in regard to smiths' work, upon the soundness of which so much depends. Iron and steel topmasts might, perhaps, with advantage be made stronger than at present by the addition of stiffening angle bars on their inside. The majority of recent accidents by dismasting have been attended or preceded by broken topmasts; and although this may be accounted for in many other ways, yet there is little doubt that the masts themselves were unduly slight.

But while the smith's work of lower masts and the scantlings of topmasts call for attention and improvement, there is much more room for amendment in regard to the rigging of sailing ships. The primary cause of most recent dismasting cases will probably be found in deficiencies either in the material or mode of rigging. A modern sailing ship starts at a disadvantage when compared with her wooden predecessors in regard to the support which is afforded to the masts by the shrouds. Not only were the old vessels broader than modern craft of the same tonnage, but the breadth available for the spread of the shrouds was increased by fitting channels on the sides. By this means a wider base was given to the rigging than is now possible with narrower ships and chain plates fitted on the inside of the sheer-strake. The angle of support afforded by the rigging is consequently less than formerly, and by so much is the possibility of damage to the masts and spars increased.

The use of wire rigging has not been attended with all the advantages which were expected of it. At first the wire ropes supplied for the purpose were all that could be desired; but competition in prices has done its work in this branch of industry as in others, so that now there are inferior qualities in the market, which are often used by builders who are building a low-priced ship. The chief defect of the low-classed wire rope is found in the readiness and extent to which it will stretch. This is not due to ductility of the wires, but to looseness of twisting and to the presence of an unduly large hempen core at the centre of the rope. The diameter of such a rope affords no criterion of its tenacity, as it may be made of fewer strands than a good wire rope of smaller size. Much of this inferior wire rope is now being used for rigging purposes, and in this fact may be seen one very potent factor in bringing about dismasting casualties. The task of rigging a ship is evidently one demanding great care and conscientious attention; but yet such work is commonly sub-let to the lowest bidder. So eager are riggers for work in dull times such as the present, that they will under-bid each other to such an extent as to leave no profit to the one getting the job, should he do it as it ought to be done. One consequence of this is seen in the frequent neglect to properly beat down the shrouds upon the bolsters at the mast-head. Combined with the inherent stretching qualities of the wire of which the shrouds are made, there results a commonly manifested tendency for the shrouds and standing rigging generally to slacken directly the vessel gets to sea. Now, until the last ten years, the shrouds were attached to the chain plates by means of hempen rope lanyards passing through dead eyes. Whenever the rigging stretched, and consequently became slack, the lanyards were set up. But the hempen lanyards were, to some extent elastic, and thereby they relieve the shrouds of stresses which might otherwise have stretched them. Rigging screws have now taken the place of the old-fashioned lanyards, and although the new contrivance affords greater facilities for tightening up the rigging than did the old one, yet it is altogether wanting in that elasticity which was so conducive to the endurance and efficiency of the standing rigging under the old system. Moreover the greater facility for tightening the rigging, to which allusion has been made, seems to be turned into one of the most serious sources of disaster. Nothing is easier than to put a lever into a hole in the side of the tube of a rigging screw, and therewith heave it up; and yet unless this be done with judgment and caution, it would be better far that the whole rigging were slack. For by unduly tightening one shroud or back-stay as compared with its fellows, the stress which should be shared by all is brought suddenly to bear upon one wire rope. Should that rope break, which it is very likely to do, then there are fewer shrouds and back-stays left to do duty; and in that way such disasters as are being considered very commonly take place.

The rigging screws—or rather the tubes in which they fit—are often very short, thereby allowing but a limited travel or drift, and consequently affording a capability of overtaking only a portion of the stretching which may take place in the wire rigging during a voyage. The tube in question is actually an elongated nut with a screw fitting into it at both extremities of the hole. Half the length of the tube or nut is, therefore, the amount of stretch which can be taken up, and as the tubes are frequently no more than 14in. to 16in. in length, it is quite clear that they are not equal to overtaking the undue stretch of an inferior wire rope. So long as this class of rope is employed, and the same carelessness is practised in fitting the rigging at the mast-head as that to which reference has been made, it is obviously prudent to increase the length of the tubes to the rigging screws. Under any circumstances, indeed, an increase in their length seems desirable, especially in those for top-mast and top-gallant backstays, which being so much longer than the shrouds, are therefore likely to stretch more.

The extra weight carried by the top-mast in the form of a second top-gallant yard—such as is required when double top-gallant sails are fitted—is a source of danger to those masts which can only be provided against by fitting additional backstays. The tendency is everywhere to diminish cost of maintenance, whether it be in regard to ships or any other class of property. The reduction in the number of the crew, rendered possible by the use of double top-sails and top-gallant sails, offers a strong inducement for shipowners to adopt these arrangements of rigging in their ships; so that we have overburdened masts and inferior wire rigging, and, at the same time, fewer seamen to cope with the dangers attendant upon a sudden squall or continued bad weather. Added to all this, the seamen now to be found in our mercantile marine are, as a body, far inferior to any that ever before sailed in British ships. No means have been afforded for the proper training of mercantile seamen since the abandonment of the apprenticeship system, and the crews of merchant ships now largely consist of foreigners. The development of steam navigation has necessarily tended to interfere with the training of seamen; and it is not considered essential that masters of steamers should first learn the art of seamanship in sailing vessels. It seems, therefore, that stowage, workmanship, material, and seamen are often not of the best in sailing ships, but rather of a contrary character. Hurried loading, piece-work prices, cheap navigation, economical working, and the other consequences of competition, all seem to co-operate in bringing about disaster by dismasting. What is to be done, and what hope is there of amendment? Underwriters are beginning to feel the pinch, and to trace the quarter from whence it comes. Premium rates for certain classes of shipping property will therefore rise to such a pitch that the owners of that property will doubtless find it to their advantage to pay a better price for their ships and expend more upon their navigation and management. They will also, perhaps, see it to be their advantage to shun those shipbuilders who make profit their sole concern, and who disregard the safety and efficiency of what they produce.

AN ENGINEERING DEGREE.

A PROPOSAL for instituting a degree in engineering was brought forward last year at the meeting of University Convocation, but after some discussion the proposal was referred to the Annual Committee for consideration and report. This report was presented by Professor W. C. Unwin at the meeting of the Convocation last week, and it appears probable that the proposal will now be carried into effect. Professor Unwin moved: "That it is desirable that a scientific degree suitable for engineering students should be instituted by the London University." He said the engineering profession had become most important, and it was recognised more and more among engineers that some scientific education was becoming more and more necessary. There were now recognised schools of engineering in many Universities. A school of engineering had been established in Cambridge, and only last week it was decided that the subject was of sufficient importance to have a tripos to itself. Mr. W. L. Carpenter, B.A., B.Sc., seconded the resolution, which was carried, as was also another approving of the provisional scheme drawn up by the Annual Committee. The Committee obtained outside information and opinion on the matter from the principal teachers of engineering, and especially from those in colleges affiliated to the London University. Degrees in engineering are granted by the Universities of Dublin, Glasgow, Edinburgh, the Royal of Ireland, the Victoria, and the St. Andrew's. At Cambridge a degree is being established, and nearly all the teachers of engineering are in favour of a degree suitable for students likely to become engineers; but in establishing a degree in engineering, one of the first questions which arise is, naturally, whether it could be made a professional degree as in medicine, and to this the whole active engineering world would of course emphatically answer in the negative, inasmuch as no man is an engineer at the end of a college engineering education, who can, except as an empty form, be the recipient of a professional degree. At the end of his college and technical institution course at, say, twenty-one years of age, a man can only say he has received that education which will enable him to become an engineer. He is not an engineer until he has been some years at work, gradually acquiring facility and certainty in the application of his theoretic training, and learning by contact with, and by doing real work, how very much the circumstances and conditions of works and materials may practically affect any engineering projects, schemes, and operations. We are very glad to see in the report of the Committee the views of the engineering profession so well expressed as in the following:—"To the institution of such a degree by the University of London there appear to your Committee to be insuperable objections. Engineering as a profession must be learned in the workshop or office of an engineer, and it is only after several years of practical experience that an engineer masters even the rudiments of professional knowledge. Your Committee do not think that any certificates of such practical experience would form a trustworthy condition for granting a degree, or that the University could itself conveniently or safely undertake the task of estimating the value of such certificates. At the same time it appeared to your Committee that a scientific degree suitable for students who proposed to become engineers was desirable, and would be valued. There are now engineering schools in many colleges, and students in such schools necessarily specialise their study at an early stage. The existing science degrees are not suitable for engineering students, partly because they involve a knowledge of such subjects as biology, which an engineering student has not time to acquire, partly because they do not recognise branches of science which form a necessary basis of engineering practice. Your Committee therefore recommend that a degree suitable for engineering students should be instituted. They are of opinion that there should be two examinations for the degree, corresponding to those for the B.Sc. degree, and they would include the examinations in the faculty of science." The examinations which it is proposed should be passed by those upon whom the degree would be conferred appear to include subjects which are essential to real engineering knowledge, and are much of the order of those upon which the B Sc. or D.Sc. degree are granted. A degree would no doubt help those students who obtained it to a start in their career; but the question arises, are young men likely to be able to pass these examinations before they have reached the age at which the pursuit of the practical side of their education becomes too late, or whether they would pass them with the mixed system of theoretical and practical training, such, for instance, as that pursued at the Bristol College. The notion of giving a professional degree to men as proposed at Cambridge or at Dublin, after a college education, with some playing at work in College workshops, is to be deprecated. Nothing partaking of the character, or seeming to indicate professional standing, can be of service, because if given upon a college and technical school education, it would soon be ignored as indicating anything. As a student's degree, however, it ought to be of considerable value. Convocation has approved the provisional scheme, including the suggested distinctive title of Bachelor of Mechanical Science or Bachelor of Engineering, and has referred it to the Senate. We most distinctly prefer the title Bachelor of Mechanical Science, because it shows that a student stands high in the science most necessary to engineering, and would not become useless by being very soon meaningless, as would Bachelor of Engineering. The real significance of the engineering degree would, however, soon settle itself.

SOUTH DURHAM SALT BORINGS.

It is some time since we have referred in THE ENGINEER to the progress of the salt industry in South Durham. The early borings on the north bank of the Tees were those of Bell Brothers; but the firm is not now the only maker of salt, for two other firms are producing salt, and the boring of a third firm is now approaching completion at Haverton Hill; and on the south bank of the Tees Messrs. Bolckow, Vaughan, and Co. have for a little while been producing salt, and they hope soon to become producers at their Middlesbrough works also. The area of the trade is thus gradually extending, and is likely to extend, for not only is a large portion of the chemical industry on the Tyne supplied from South Durham with salt, but there is also being cultivated a sale to other markets. The demand for salt for purposes of curing and for purposes of manufacture is growing, and its cheapness as well as its nearness to the seaboard enables it to command many markets. But there are difficulties in regard to the production to be met from time to time, and these affect seriously the bore holes of some of the producers. The "life" of a bore hole cannot be exactly defined in terms of time; but it is growing evident that as the salt is withdrawn, there are some dangers to be guarded against. There is a tendency in some of the bore holes for the pressure of the superincumbent strata on the part whence the salt has been liquefied to cause the piping to be so distorted that at times it refuses to act; and there are also difficulties due to filling-up of the tubing at several parts to be dealt with. At times these difficulties have become so great that several bore holes have been laid aside from work at the same period; and the experience which has been slowly gathered is being frequently added to. It is by no means easy to ascertain how these stoppages in whole or part will affect the output of salt: but it is certain that it makes an addition to the supply from other and more trustworthy parts, needful from time to time, and this has had to be done of late by some of the users of Durham salt. But the preparations to extend the output to which we have referred will affect this. There are now saltpans enough to do the work well, but it is the brine supply which is from time to time affected; and this may be partially dealt with by the construction of larger reservoirs for brine. But this would still be a very inadequate provision, and the result will be that the boring of additional holes will be requisite. Indeed the opinion has been expressed that there should be a reserve of twenty per cent.—that the capacity of production should not be only equal to but fully one-fifth above that of the requirements, so that there should be an ample reserve to fall back upon in case of stoppage of bore holes. But in any case there will be need now for a more ample provision, and it is probable that others may enter into the almost illimitable field on the northern bank of the Tees. Slowly its limits are becoming proved, and there is thus less of the risk that there was at first in the commencement of the industry, when none of the boundaries of the area were known. Now these have been found in at least one direction, whilst the proving of the salt in other localities has enabled it to be said that its boundaries there are beyond a certain point. It may, then, be anticipated that there will be an enlarged production of the salt in Durham.

FOREIGN COMPETITION.

A SHEFFIELD workman, who has spent ten years in New Zealand, has addressed some sensible words to his countrymen here, and he says the American tools are fast driving the English out of Colonial markets; and diligently inquiring after the reason, he was told by the workmen that American tools are lighter, handier, and better finished. He asks Sheffield workmen a few plain questions: "Are there not among you," he says, "men who are able to make an axe as good as an American can?" He thinks it is because they have never tried, and adds, "that there is not an axe of English make sold in the Colonies at the present time." Then as to the shovels. When he came to the Colonies ten years ago, a number of English shovels made by a firm near Birmingham were sold; not one is now to be seen in the country. They were made of rotten material that would not last any time, and he had seen English short-handle navvy's shovels selling at five shillings and American at seven shillings, and yet the American were preferred at the higher price. "The American shovel," he says, "is lighter, and is better material." If Sheffield wants to maintain its position as the leading edge-tool makers in the world, he warns Sheffield men that they must not fall into the errors of the Geneva watchmakers, and try to make too cheap, but always take care to put in good material and good workmanship. He makes special reference to forks for manure. "The English forks," he says, "are too heavy, with square prongs, while the Americans have much lighter prongs of an oval shape, and made with the very best steel." Carpenters prefer English augers, which are better able to stand the hard wood. He warns English workmen against strikes, telling them that while they and their employers are quarrelling the foreigner steps in and steals their trade. New Zealanders are anxious to give preference to English goods, because England is their market. America does not take their grain or their meat, and New Zealanders do not want American hardwares. They are trying to get a tariff put upon goods imported from America, and to increase the use of English goods, as England is their only customer.

PROPOSED RAILWAYS IN BURMAH AND SIAM.

WE recently reviewed at some length the proposals made by Messrs. Colquhoun and Hallett for developing the trade of our newly acquired province of Upper Burmah. We are pleased to hear that negotiations are now proceeding with every prospect of successful result for giving practical effect to those proposals. An English company is to be formed with the object of acquiring from the Indian Government the existing railways in Lower Burmah and adding to them those extensions which our previous article described. To effect this it is understood that the company is to raise capital sufficient for the purchase of the present lines, viz., £3,000,000 sterling, while for the contemplated extensions, estimated to cost about £3,500,000, the Indian Government is to advance money at a specified rate of interest. Following the example set during the early days of railway construction in India, the Government of that country is to guarantee 4 per cent. interest on all the capital for five years after the conclusion of the contract, and thereafter at 3½ per cent. interest. All the land required to be taken up is to be provided free of cost to the company. In return for these concessions the Government will secure the right of taking over the lines after twenty-five years, and of controlling within certain limits the charges for passengers and freight. It is too early as yet to say that these arrangements have been definitely settled. There are those who hold that the days for guaranteeing on Indian lines have passed by; but Upper Burmah, as a newly acquired territory, can hardly come within the operation of the reasons assigned for such an opinion. Still the fact that the lines hitherto constructed within Lower Burmah have been paying regularly 6 per cent., would seem to show that no bad bargain for the Indian authorities is contemplated, and they cannot be blind to the great public advantages to be secured by the arrangement proposed.

THE INSTITUTION OF CIVIL ENGINEERS.

THE annual general meeting of the Institution of Civil Engineers takes place next Tuesday, when the annual report will be presented and the election of the President and Council will be made. This meeting is usually the occasion of a very large attendance, much of the order of a conversazione, and it may be expected that the numbers attending this year will be unusually great. The Institution is, perhaps, the most systematically, rigidly, and fairly conducted of the large professional societies, but the members have not paid quite as much attention to their part of its conduct as affected by the election of Council as they should and perhaps will do. Not a single undesirable election has ever been made; but there is something deplorably weak in the voting, which for year after year, and many years, continues to place the same men in the same position without regard to the numbers of eligible and deserving men of high ability who should have a place on the Council for at least a few years, not only as a recognition, but as a necessity for the welfare of the Institution, the Council of which, like all others, has a tendency to become "groovy"—a tendency fatal to the advancement of engineering science and practice. Members freely complain of the absurd continuation of the re-elections that have occurred during the past ten or twelve years; but the members must be reminded that on the list of proposed members of Council the names of men who have not yet been elected, but who are foremost amongst engineers, are placed for their selection, and it is therefore their own fault if the composition of the Council becomes stereotyped.

LITERATURE.

Yacht Architecture. By DIXON KEMP. London: Horace Cox, the *Field* Office. 1886.

THE developments of recent years in naval architecture have not been limited to the Royal Navy and the mercantile marine, but have been extended into the domain of the yachtsman also, so that the racing yacht of the present day shows fully as many points of advantage over her predecessor of twenty years ago as do the great ocean racers in the Atlantic and East Indian lines of steamers over the corresponding vessels which were employed in those trades at that time. It is true that the developments have been made upon different qualities and conditions in the two cases; for while steam propulsion has achieved successes in the one, it has been chiefly by the improvement of sailing capabilities that our yachting fleet has advanced in efficiency. But the influence of steam has been felt, too, among yachtsmen, and there can be little doubt that the influence has been on the whole rather antagonistic than otherwise to the interests of yacht racing and therefore of improvement in the design of sailing yachts. That the sailing capabilities of yachts should have continued to improve, notwithstanding the many temptations to employ steam power, is one of the strongest evidences that could be adduced of the scientific study which has been given to yacht designing. For, at a time when fewer sailing yachts were built, the advancement made in their performances has been more rapid than when there were greater opportunies afforded for a chance success to occur. The marvellous results obtained with steam launches and more recently with torpedo boats have been a strong incentive to the building of steam yachts, even were there no other motives for encouraging their production in this age of rapid movement and nervous restlessness. It is therefore satisfactory to find that while many yachtsmen strive to emulate the mechanical swiftness and regularity of a Cunarder when taking their summer holiday cruise, there are yet a great many of an older school of yachting taste who still cling tenaciously to the sailing cutter, yawl, and schooner, and make it their task of pleasure to curb the wind most effectually to their service. Among those who have worked hardest and best in the attainment of this object there is no one who better deserves the thanks of yachtsmen than Mr. Dixon Kemp, the author of the massive volume now before us. Mr. Dixon Kemp is by no means a stranger in the paths of yachting literature, for in addition to sundry contributions to the Institution of Naval Architects, he has also written volumes on "Yacht Designing" and "Yacht and Boat Sailing"; but perhaps the greatest service rendered by that gentleman to the cause of yacht development was the action he took in regard to the formation of "Lloyd's Yacht Registry" in 1877. It was chiefly due to Mr. Dixon Kemp that "Lloyd's Registry" undertook the important and responsible duty of surveying and classifying yachts for insertion in the "Yacht Register," which is published every year by that Society. The construction of wood, iron, steel, and composite yachts, both sailing and steam, is now regulated by the rules prepared in 1877 under the direction of Lloyd's Committee, and the condition of classed yachts is now periodically ascertained by Lloyd's surveyors. This system is most convenient to intending purchasers of yachts, who find in the classification certificates a guarantee of their satisfactory construction, and the advantage of the system is correspondingly felt by those who have a yacht to sell. But over and above all this, the quality of yacht construction under skilful and vigilant supervision must of necessity be improved, and it is in this respect that yacht architecture was most largely benefitted by the classification system initiated by Mr. Dixon Kemp about ten years ago.

The work before us is characteristic of all that Mr. Kemp takes in hand. It contains evidences of searching inquiry and hard work. No source of information seems to have been neglected, nor has the author omitted to consult those whose opinions are worthy of attention upon the many points brought under discussion. The chapter upon yacht building is particularly detailed and instructive, but unfortunately the treatment is limited to the case of wood yachts. This is probably due to Mr. Kemp's better acquaintance with southern builders and practice than with those which prevail in the North, especially in Scotland. Some of the finest racing yachts built during the past year or two have been either of iron, steel, or composite construction. A chapter upon the practical details of such vessels would have added value to the work, and it is to be hoped that Mr. Kemp may see his way to make an addition of this kind in a future edition of his book.

The theoretical principles which govern all naval construction, whether of yachts or more prosaic craft, are, upon the whole, correctly described and explained. We must, however, take exception to the statement on page twenty-seven, that there is no such thing as stability of form as distinguished from the stability due to the position of the centre of gravity. Of course it is quite true that the stability of a vessel varies with the height of metacentre above the centre of gravity, and that "form" has no weight and therefore no centre of gravity. But "form," as commonly understood in its application to the subject under consideration, refers to that of the volume of water displaced by the vessel at different angles of inclination. Variations in the shape of that volume of water will modify the movement of the centre of buoyancy as the vessel is inclined, and with it that of the metacentre. It is in this way that form of body plays its part in determining stability, and the actual righting moment is then governed by the position of the centre of gravity of the weights in the hull and cargo, which latter takes the form of lead or iron ballast in a yacht. Mr. Kemp is quite correct in saying that there is no such thing as "artificial stability;" for the whole phenomenon is a natural one. But people who use the terms which he condemns may yet have a correct conception of what really takes place, although their nomenclature is not a strictly scientific one. That Mr. Dixon Kemp is himself well aware of the influence of form upon stability is shown by a remark on page thirty-nine, in which he refers to "the enormous initial stiffness of vessels which are relatively broad and shallow." "Frequently, too," he says, "in practice a vessel has less weight than another of the same length and yet has the same righting power." What is the cause of this, if it be not the difference in form in the two cases? As Mr. Kemp must well know, a flat raft is the form of maximum stability; and that, too, regardless of its weight. The centre of gravity in such a raft cannot be low; but the metacentre must be high.

The information regarding steam machinery for yachts, which it appears was contributed by Mr. G. R. Dunell, will prove very valuable to present and intending steam yacht owners, and not without value to their designers and builders. While the theoretical considerations laid down in the treatise regarding all that concerns buoyancy, stability, resistance, rolling, pitching, sailing and steering, are in accordance with accepted principles and the most approved teaching, they will yet, we think, prove less valuable to yachtsmen generally than the vast store of data, including the designs of successful yachts, which the book contains. In this respect the work is a treasury of ever-needed and ever-useful facts and results, and the plates are executed with neatness and apparently with accuracy. Mr. Dixon Kemp is to be congratulated upon the success of his efforts in collecting these materials into a volume which should hereafter be a *vade mecum* in every yacht builders' drawing-office.

Statics and Dynamics for Engineering Students. By Professor J. P. CHURCH. New York: John Wiley and Sons. 1886.

WE notice some good points about this book. For example, page 1 contains an excellent definition of *force* worth quoting:—"A *force* is one of a pair of equal, opposite, and simultaneous actions between two bodies, by which the state of their motions is altered or a change of form in the bodies themselves is effected." Again, at page 77, a clear explanation of the two simultaneous and mutually balancing forces called "centrifugal" and "centripetal" is given. It is a foolish habit of some mechanicians of the present day to fancy they show superior wisdom by denying the existence of anything that can be called centrifugal force.

Also the book is very well printed on good paper, this being usually the case with Messrs. Wiley and Sons' publications. Again it is of a readable size. Otherwise we cannot say much in its favour. The methods of investigation adopted are needlessly cumbersome and tedious. The examples and illustrations are often so fanciful as to be decidedly unhealthy for students of practical engineering. Indeed the whole subject almost seems to be looked upon solely as the vehicle for explaining a number of ingenious mathematical problems. It appears as if the author considered the mathematical exercise the important part of the study, and not the acquisition of real mechanical facts and results. Again the grammar is frequently decidedly bad. Bad grammar indicates lack of clear logical ideas, and clearness of logical idea is as necessary in mechanical study as in any other, or even more so. Want of it appears in this book, also in the use of such phrases as "the velocity of a force," "the projection of a displacement upon a force," and others that seem equally slipshod.

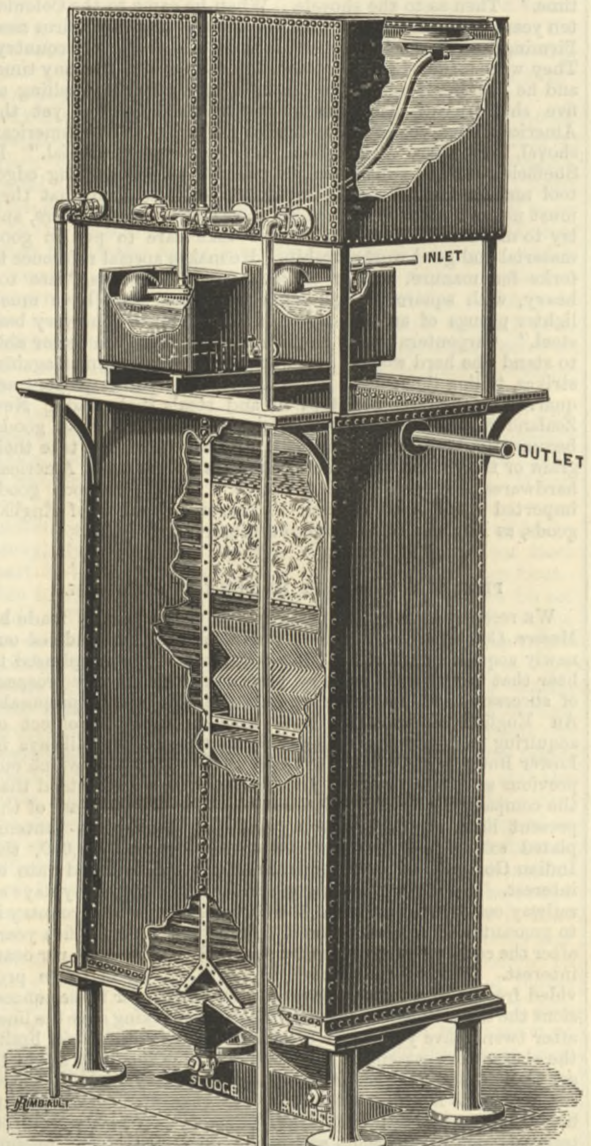
The old dismal attempt at a "proof of the parallelogram of forces" is renewed. This is ushered in by the statement, "It is a matter of experience that besides the point of application already spoken of, viz., that of application of a force, any other may be chosen in the line of action of the force." This is, however, not really a matter of experience. It is a mathematical assumption which, as can be easily shown, does not affect the accuracy of calculations regarding forces so long as only the moments and the vector sums of the forces are considered. Now, it is only with regard to moments and vector sums that it is a legitimate device to substitute a "resultant" for a complex set of forces. This substitution consists in one of the many graphic constructions which have reached such a rich development in modern mechanics, and of which the antiquated and now disused "parallelogram of forces" is the elemental origin in its first clumsy shape. So long as force moments and force vector sums are looked on from a geometrical point of view only, the proof of the correctness of these methods of finding resultants is a matter of "pure" mathematics, and does not in the least depend upon "matters of experience" such as referred to above. The proof that the sum of the force moments is the turning power exerted so far as the acceleration of average angular velocity is concerned, and the proof that the vector sum of the forces is the power exerted in accelerating the average translatory momentum, are physical proofs with which the ancient attempts at "proofs of the parallelogram of forces" have as little to do as lunar attraction has to do with boiling a kettle. The engineering student should never forget that it is only with regard to these averages that he can substitute the resultant for the actual forces. So far as regards distribution of stress and strain produced by the forces, the substitution may not be made. It so happens that this latter is a more commonly made kind of calculation than the former.

At one part of this book we are told that "the product of a mass by its velocity is sometimes called its momentum." It also strikes us as odd that the composition, &c., of motions, velocities, and accelerations of velocity should come a hundred pages later than the corresponding problems regarding forces. Regarding friction, it is rather late in the day to assert that it "is the same at all velocities," and that it is independent of the normal intensity of pressure. The treatment of "rolling friction" is also disappointing, at least when found in a book published in 1886.

HOWATSON'S WATER SOFTENER AND PURIFIER.

THE apparatus illustrated by the accompanying engravings is made by Messrs. J. W. Gray and Sons, 115, Leadenhall-street, under the patents of Mr. A. Howatson, who has made use of the fact that water becomes purified by the action which is set up when the water is forced to pass over and between surfaces. Under these circumstances, whether the surfaces be those of fine or coarse sand or of plates of iron placed close together so that the water must pass through spaces whose surfaces are large as compared with the volume of the space they enclose, the water gives up inorganic, and, to some extent, organic impurities which make themselves evident by accretion or incrustation. In the water softener and purifier illustrated, the water after having been mixed automatically with the necessary proportion of lime, and in some cases caustic soda, passes from the one tank in which this mixture takes place to the bottom of the other, and in its upward movement passes between the series of thin iron plates placed on edge and at an angle as shown. In passing between these the water gives up its lime, bicarbonate of lime, sulphate of lime, and carbonate of magnesia in a remarkable manner, and by the time it has reached the packing of wood shavings or other material above the iron plates it is perfectly clear; and, when treated for softening purposes, is reduced from two to four degrees of hardness. As employed for softening water for steam boilers or bleaching works its action is perfect, and a comparatively small size apparatus will continuously soften and purify a large quantity. Thus an apparatus occupying a floor space 6ft. by 3ft. and 9ft. 6in. in height will deal continuously with 500 gallons of London water per hour.

The apparatus as shown is fitted to purify water by what is known as the soda lime process; it is, however, as perfect in its action for any other chemical treatment of the water. The apparatus is composed of two upright tanks; the one on the left, into which the water and chemicals are first introduced, is made large enough to allow the complete chemical action to take place, the water is then led by a pipe at the bottom into the right-hand tank, which is constructed as a subsidence filter, and is shown in section—the lime, soda, or other chemical solution is prepared in the two top tanks—working alternately—and flows into the small tank underneath, which is fitted with a float to



HOWATSON'S WATER SOFTENER AND PURIFIER.

preserve a constant level, the water to be purified flows into the other small tank, also fitted with a float to maintain the level; both these tanks are fitted with cocks and nozzles, so that with constant levels in the two small tanks and nozzles of different sizes, the flow of water to be purified, and the chemical solution for the purification, can be regulated to the greatest accuracy, or is made absolutely automatic.

For instance, if the apparatus is to purify 500 gallons an hour, and five per cent. of the chemical solution is required for the purification, the nozzle which runs 500 gallons an hour is put on the water cock, and the one to run twenty-five gallons an hour on the chemical solution cock. By this simple arrangement the apparatus can be set to work by the most unpractised hand, and a certain result secured. The water and chemical solution are brought into intimate contact by flowing into a trough and then into the bottom left-hand tank, where the chemical action is completed; the water then passes in a milky-white state into the right-hand tank or filter, and passing up between the plates, gets rid of all solid impurities and passes off at the top, pure, clear, and ready for use. The plates are set at an angle, so that the deposit slides from one to the other, until it falls into the V-shaped bottom, and is drawn off at intervals by opening the sludge cocks shown at the bottom. The following is an analysis of water at the City office of Messrs. Gray and Son, where we have seen the apparatus at work:—Sulphate of lime, 2·60 grains per gallon; carbonate of lime, 13·93 do.; nitrate of magnesia, 1·53 do.; carbonate of magnesia, ·23 do.; chloride of sodium, 2·30 do.; oxide of iron, &c., ·07 do.; alkaline carbonates, silica and organic matter, 1·74 do.; total impurities, 22·40 grains per gallon.

The hardness is usually about twenty degrees, though it seems to vary a little. We have seen it reduced from about eighteen degrees to rather under two degrees. The apparatus also works with complete success on the dirty water of the Thames at Westminster taken during low ebb. Some idea of the action of the apparatus in purifying water when combined with the use of the softening process is shown by this. Mr. B. Dyer, F.C.S., analysed the Thames water and the effluent, and reported, "The untreated water was thick and turbid, being loaded with mud, of which it contained in suspension 100·3 grains per gallon, of which 13·1 grains were organic matter and 87·2 grains mineral matter. The treated water was particularly clear, containing less than one-fifth grains per gallon of suspended matter." The Bristol Sugar Refinery Company uses the apparatus on a large scale, softening and purifying by a 3000 gallon per hour machine, and reducing from fifteen degrees to two degrees hardness.

The movement of the water through the large tanks is very slow. Thus in the machines for doing 200 gallons per hour, the water moves through a sectional area of about two square feet. The quantity of water being 3·3 gallons per minute through this area, the velocity will be about 0·26 of a foot per minute, and thus when the accreted lime on the lower plates falls intermittently, or if it be purposely shaken, the velocity of the upward moving water is so low that the effect of such a purposely made muddiness is not distinguishable in the upper part of the apparatus.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

THE last general meeting of the second session of the above Institution was held in the Lecture Hall of the Literary and Philosophical Society, Newcastle, on Wednesday evening, May 12th. The president—Mr. W. Boyd—occupied the chair. The adjourned discussion on Messrs. Marshall and Weighton's paper on "High-speed Engines" was resumed and closed. Several important alterations in the bye-laws of the Institution were put to the meeting and adopted. The retiring president declared the result of the ballot for the officers for the ensuing year as follows:—President, Mr. W. T. Doxford; vice-presidents, Messrs. A. Coote, Wigham Richardson, and A. Taylor; councilmen, Messrs. M. Foley, A. Laing, J. P. Hall, C. W. Hutchinson, M. Sandison, and J. Tweedy. Before vacating the chair, the retiring president gave a brief summary of the important work done by the Institution during the past two years. The papers which had been read were all admitted to be of a practical and high-class character. The establishment of the new measured mile on the coast off Hartley, which had been mainly brought about by this Institution, could not fail to be of great importance to this enterprising district; and at the present time two very important sub-committees were at work—the one to investigate the progress of shipbuilding, both in our own and foreign countries, and the other having for its object the establishment of some more definite formula or rule for the nominal horse-power of engines and boilers. The progress of the Institution had certainly exceeded their most sanguine expectations, and it had already gained for itself a good name among kindred societies. He thought they had acted wisely in their choice of his successor, to whom he trusted they would give that cordial support which they had always rendered to himself, and he had no doubt the Institution would still go on and prosper. The chair was then taken by the President-elect, who returned thanks for the honour they had conferred upon him. Mr. C. W. Hutchinson then moved a vote of thanks to Mr. Boyd for his services, and spoke in high terms of the great zeal and energy displayed by him during his two years of office, which had well merited the confidence and esteem of the Institution. This was seconded by Mr. Macoll. The Secretary—Mr. Duckitt—read a letter from Mr. F. C. Marshall—who is at present in Rome—expressing his high estimation of Mr. Boyd's services, which had placed the Institution under many obligations. The resolution was carried by acclamation. Mr. Boyd thanked the members for their appreciation of his services, which he said amply repaid him for all he had done. The president then declared the second session closed.

THE MILLERS' CONVENTION IN DUBLIN.—The following are the provisional arrangements for this Convention:—Wednesday June 9th, 10 a.m.: Annual meeting, Ancient Concert Rooms. Afternoon: Visit mills. List of those open for inspection during the Convention will be published in the complete programme. 6.30 p.m.: Annual banquet, Ancient Concert Rooms.—Thursday, June 10th, 10 a.m.: Papers by Mr. T. Hubbard on "The Milling of Soft Wheat by Rolls;" Mr. G. Little, "Shall we Utilise the Latent Abilities of the Operatives Engaged in Milling?" and Mr. H. Simon on "Dynamometrical Tests as to the Power Consumed by various Machines used in Roller Mills." 1.45 p.m.: Train to Bray, thence by cars through Dargle, visiting Waterfall, returning to International Hotel, Bray, for dinner.—Friday, June 11th, 10 a.m.: Papers by Mr. S. S. Allin on "A New Water Motor;" Mr. J. Turnbull, jun., on "The Turbine as a Motive Power for Flour Mills;" and Mr. Spencer on "The Machinery for Carrying and Warehousing Grain." Afternoon: Visit mills, or local sights of special interest, viz., Old Parliament House, Trinity College, Phœnix Park, Guinness's Brewery, &c. 7 p.m.: Conversazione, music, &c. At 1 p.m. daily, lunch will be provided in the Ancient Concert Rooms, at a fixed tariff.—Saturday, June 12th, special excursion to Glendalough—round Tower and famous Ruins of Seven Churches—visiting Messrs. Comerford's New Roller Mill, Rathdrum. A special reception room will be opened in a central position for the ladies. Arrangements will be made for their entertainment whilst the members are engaged at business.

THE BRITISH ASSOCIATION.—The programme of arrangements for the Birmingham meeting of the British Association has just been issued. It meets on Wednesday, September 1st, when Sir Lyon Playfair resigns the presidency, which will be assumed by Sir William Dawson, C.M.G., F.R.S., the eminent Canadian geologist, principal of M'Gill College, Montreal. It seems peculiarly appropriate that in the year of our great Colonial Exhibition the presidency of this great scientific body should be conferred upon an eminent colonist. In the permanent staff there is no alteration, except that the new secretary, Mr. A. S. Atchison, assumes full responsibility for the first time in place of Professor Bonney. The local secretaries are Mr. J. Barham Carslake, the Rev. D. H. W. Crosskey, and Mr. C. J. Hart, and the local treasurer is Mr. J. D. Goodman. The following are the presidents of the various sections:—A, Mathematical and Physical Science, Professor G. H. Darwin, F.R.S.; B, Chemical Science, William Crookes, F.R.S.; C, Geology, Professor S. G. Bonney, F.R.S.; D, Biology, William Carruthers, F.R.S.; E, Geography, General Sir F. J. Goldsmid, K.C.S.I., C.B.; F, Economic Science and Statistics, John Biddulph Martin, F.S.S.; G, Mechanical Science, Sir James N. Douglass, M.I.C.E.; H, Anthropology, Sir George Campbell, K.C.S.I., M.P. On Thursday evening, September 2nd, there will be a *soirée*; on Friday, September 3rd, at 8.30, a discourse on "The Sense of Hearing," by Professor W. Rutherford, M.D., F.R.S.; on Monday evening, September 6th, at 8.30, a discourse on "Soap Bubbles," by A. W. Rucker, M.A., F.R.S.; on Tuesday evening, September 7th, at 8 p.m., a *soirée*. Great efforts are being made in Birmingham to render the meeting an unprecedented social as well as scientific success. Already, moreover, several of the sectional committees have had meetings to organise the work of their section. Among the exhibitions to be arranged for, we believe, is the educational collection of the Royal Geographical Society exhibited in Great Marlborough-street last winter and at present in Edinburgh.

THE TRENT GAS ENGINE.

MR. R. SIMON, NOTTINGHAM, CONSTRUCTOR.

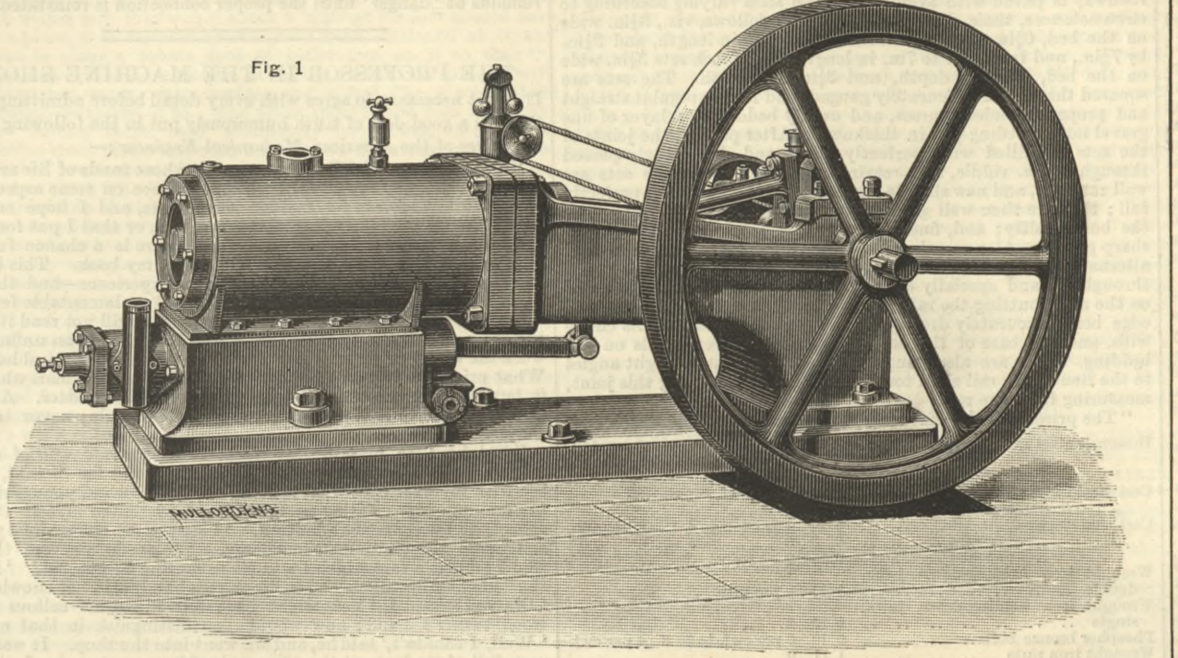


Fig. 1

THE TRENT GAS ENGINE.

THE accompanying engravings illustrate a new gas engine known as the Trent engine, and made under the patent of Mr. Richard Simon, of Nottingham. It is a compression engine, but differs very materially from any engine of the kind hitherto made in that the compressed gaseous mixture is fired in the chamber into which it is compressed. The firing is, however, effected at the time that communication between the receiver and the motor cylinder is open, and as far as the action of the gaseous mixture is concerned, the effect is much the same as though the firing actually took place in the cylinder. The general arrangement is seen from Fig. 1. Fig. 2 gives a vertical section of the cylinder, the receiver, and main valve, and Fig. 3 is a horizontal section of the ignition end of the main valve with the small ignition valve, and Figs. 4 to 8 are diagrams from the motor and compressor ends of the cylinder. The engine is simple in construction, strongly designed, and well made, gives no trouble in starting, and the main valve with its piston rings P C C^{I} and C^{II} appears to work without any material wear.

The motor piston A and the compressor piston B are formed in the trunk T, the annular space D round which forms the compressing cylinder. As shown in Fig. 2, the pistons are at the end of their outstroke, and the rings C and C 1 of the main valve cover the ports. The approaching movement of the piston and the valve will be in the direction shown by the arrows, so that the port K will be uncovered, permitting the compressed air and gas, which have entered at the inlet marked, to pass into the receiver space in which the valve works. At the same time, the exhaust port J will be uncovered by the ring C. At E, at the ignition end of the main valve, is a small valve by which the igniting flame is admitted to the space within the main valve. Taken with reference to the position shown, this is done when the main valve has made its out stroke in the direction of the arrow and returned so that the screw F has pushed the valve E from its seat. This occurs earlier or later after the motor piston has commenced its motor stroke according to the position at which the screw F is set. The master light, and the ports by which the flame is conveyed, are clearly seen in Fig. 3, in which F is in contact with the end of the spindle of the valve E, and the flame is passing to the whole of the contents of the hollow main valve and through the holes H to the receiver. The indicator diagrams are given as affording some indication of the working of the engine, but as they were taken with an old Richards' indicator they afford no satisfactory actual data. Fig. 4 was taken with the engine running at about 160 revolutions, and doing from 3-horse to 4-horse work, there being at the time no more work available to put upon it. The period of ignition is shown, and by experience with gas engines and Richards' indicators, those acquainted with gas engine work will readily extract from the very high jump at moment of ignition and the oscillating curve after it, some indication of comparative value when used with reference to the following diagrams. Fig. 5 is from the engine running under the same conditions, but the set screw F was screwed in so that ignition took place earlier, and consequently the full pressure in the cylinder was not so suddenly achieved. The highest pressure shown is, however, about the same, but the succeeding pressure is better maintained, at least if we may judge at all by the indicator, the speed being the same; it is difficult otherwise to account for the greater oscillation in the one than the other case. Fig. 6 is from the engine running at about 165 revolutions per minute, and with a very weak mixture. Fig. 7 is from the compressor cylinder, and shows not only the gradual growth of the pressure on the instroke to 50 lb., but the great fall of the indicator piston below the real pressure line when the motor cylinder port opens, the fall to the heel point X and the subsequent rise being thus entirely due to the indicator inertia. Fig. 8 was taken to show the difference with the engine running slowly and the motor port thus opening gradually. The effect was, as will be seen, almost complete elimination of the drop.

The admission of the gas is controlled by the governor, but gas and air enter the compression pump mixed. Complete exhaust takes place, at least, as complete as the time necessary to cover the port J by the port C of the valve will permit—that is to say, there is more complete exhaust than in most steam engine cylinders. It will be observed that the engine receives an impulse at each stroke. The arrangement by which the gas is taken secures a nearly uniform suction, and hence gas regulators are not required. In Fig 2 the relative positions of the piston and valve are those when the piston A is near the outer end of its stroke. The section, Fig. 3, shows position of valve at moment of ignition.

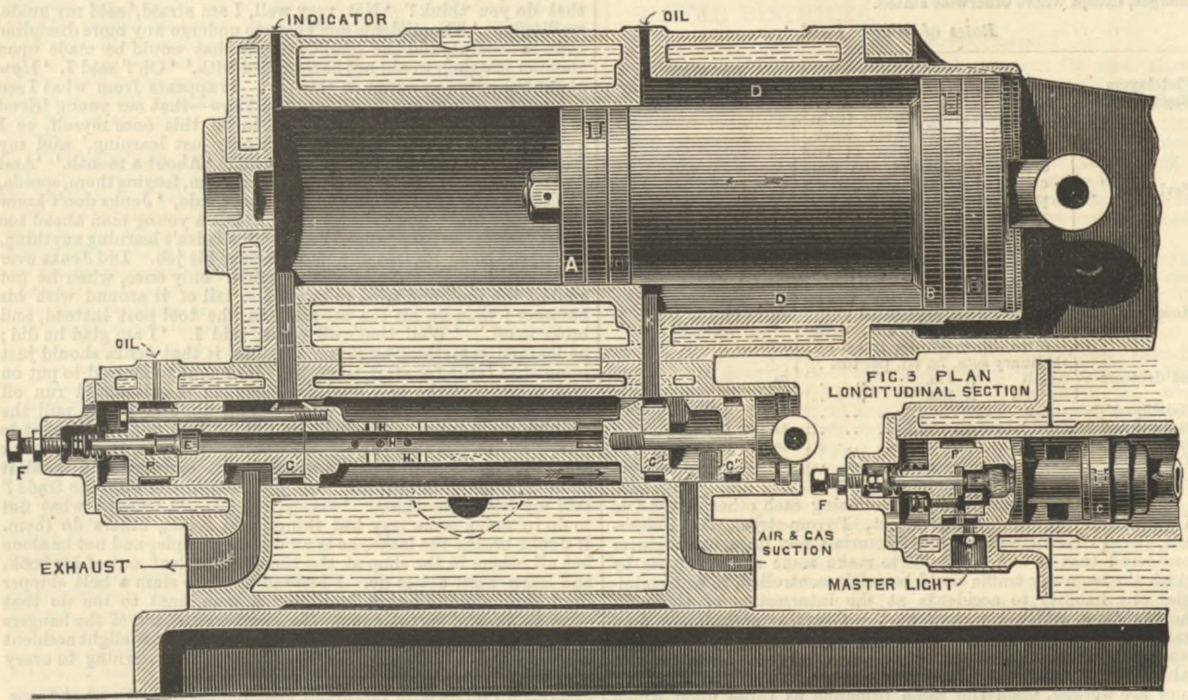
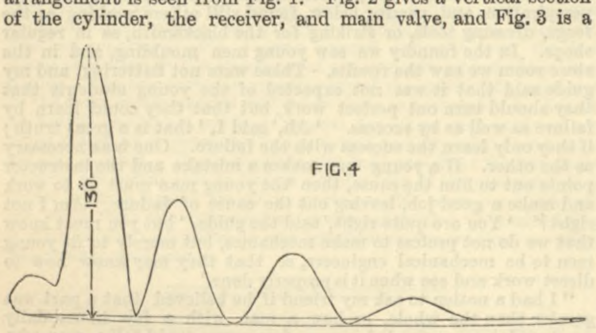
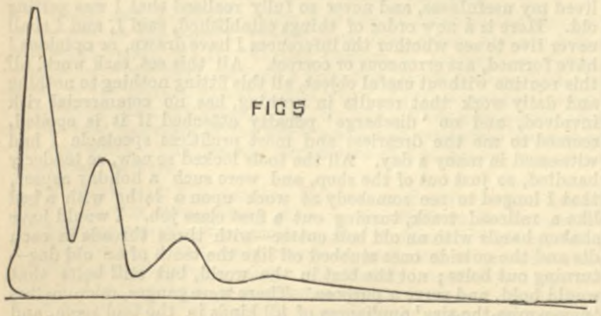
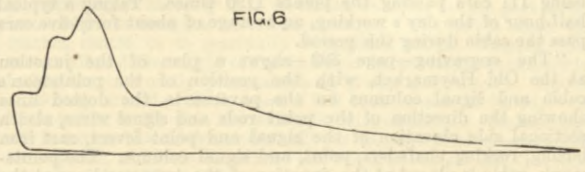
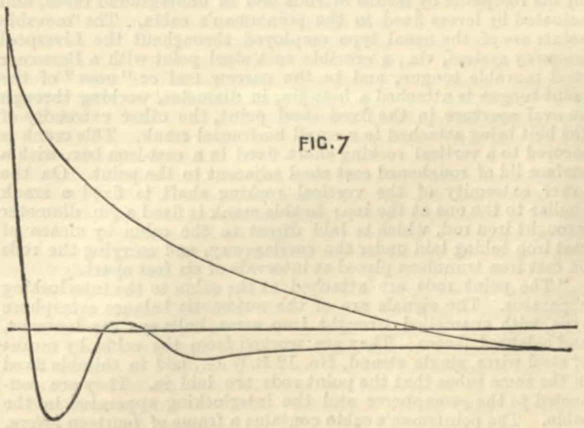


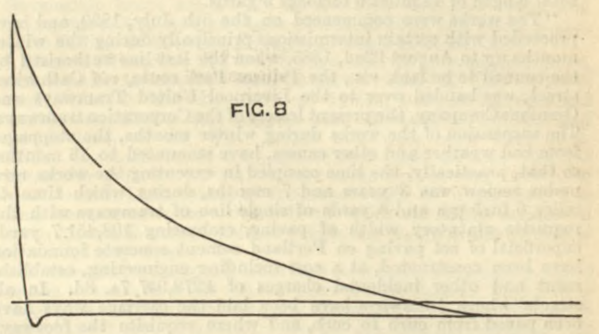
FIG. 2 ELEVATION
LONGITUDINAL SECTION











THE BRIGHTON ELECTRIC RAILWAY.

THIS line—particulars of which have appeared in previous issues of this journal—has been in constant operation over two years, and we now give some particulars as to the result of the working during this period. The line is rather under a mile in length, and includes some heavy gradients on sharp curves, the gauge being 2ft. 9in. The speed is limited to eight miles an hour, although a speed of over twenty-five miles has been obtained. The current is transmitted along the rails, which are fastened to wooden sleepers resting on the shingle, no special insulation being used. Each car seats thirty passengers, and the motor car can draw another car if necessary. The plant comprises two cars fitted with motors, one 8-horse power gas engine, one 12-horse power gas engine, one Siemens D2 series dynamo, and one Siemens D2 compound dynamo. The working expenses for one year—average of two years—are as follows:—

	£	s.	d.
Electrical machinery: New commutators and brushes	10	0	6
Gas engines: Refacing slides, &c.	6	9	10¼
Oil and waste, that used for axles included	10	1	3
Gas, including that used to light premises, price 3s. 3d. per 1000 cubic feet	114	3	0¼
Attendant: Fifty-two weeks at 18s.	46	16	0
	£187	10	8

The gross earnings per car mile are 1s. 7½d.; the gross expenses per car mile are 11½d.—all renewals being paid out of revenue; car mileage per annum, 23,475; cost of haulage per car mile 1·92d., barely 2d.—this includes the engine attendant. Only one car is running, except on Bank Holidays, &c., when two are used, on which occasions nearly all the power of the 12-horse engine is used. The repairs to the electrical machinery amount to five per cent. per annum, and to the gas engine about two and a half per cent. The only repairs to the electrical machinery of the two cars, the work having been nearly equally divided between them, each car having run about 25,000 miles, have been one new commutator and one spindle bush, relined with soft metal. That, therefore, represents the wear and tear of the electrical machinery for nearly 50,000 miles running. The extra cost of running two cars is very slight, only about one-half more gas being required, and the other expenses being scarcely affected. In cases where several cars would be used, and the prime mover a compound engine of the best construction, the cost would be far less, as a gas engine not working to its full power is by no means an economical motor, the friction diagram of a 12-H.P. engine being nearly 7-H.P. The above result may certainly be considered very gratifying, both to the proprietor of the line, Mr. Magnus Volk, and also to all those interested in electric locomotion.

THE LARGEST GASHOLDERS IN THE WORLD

WITH this impression we commence the publication of a series of detail drawings of the great gasholders recently constructed from the designs of Mr. Chas. Hunt, M.I.C.E., at Birmingham. A portion of the plan of the holders showing top plating, standard guides and rollers, and a part elevation of a holder, ladders, stages, &c., are given on page 393. The holders, of which there are two, vary from 230ft. to 236ft. in diameter, and hold 6,500,000 cubic feet each. A full description will appear with future illustrations.

THE TRAMWAYS OF LIVERPOOL.

A MOST interesting report has been written by Mr. Dunscombe, city engineer, as to works executed in tramway streets within the city of Liverpool from 1880 to 1885. The greater part of this report we reproduce. On page 392 will be found complete illustrations of the tramways. These illustrations explain, and are referred to in Mr. Dunscombe's report.

"In the year 1880 the Corporation purchased by agreement from the Liverpool United Tramway and Omnibus Company, under the powers conferred upon them by previous Acts, the then existing tramways, which consisted of the Northern and Southern lines, the Inner Circle and the Whitechapel line, the former lines being in such a defective condition as to require immediate re-construction. In the years 1879, 1881, 1883, and 1884 Provisional Orders were obtained by the corporation for extensions, comprising an equivalent length of single line of 51 miles 7 furlongs 137 yards, and of this length 37 miles 7 furlongs 36 yards have been constructed, which, together with the reconstructed lines, makes a total length of 45 miles 6 furlongs 5 yards.

"The works were commenced on the 5th July, 1880, and have proceeded with certain intermissions principally during the winter months up to August 22nd, 1885, when the last line authorised by the council to be laid, viz., the Princes Park route, *viâ* Catharine-street, was handed over to the Liverpool United Tramways and Omnibus Company, the present lessees of the Corporation tramways. The suspension of the works during winter months, the stoppages from bad weather and other causes, have amounted to 18 months, so that, practically, the time occupied in executing the works now under review was 3 years and 7 months, during which time 45 miles 6 furlongs and 5 yards of single line of tramways with the requisite statutory width of paving, embracing 198,451·7 yards superficial of set paving on Portland cement concrete foundation have been constructed, at a cost including engineering, establishment and other incidental charges of £278,947 7s. 8d. In all streets where tramways have been laid the carriage ways have been paved from curb to curb, and where requisite the footways renewed, and other incidental works appertaining thereto, such as the completion of all requisite lighting and sewerage, have been executed so as to avoid as far as possible future interference with the thoroughfares in question. The total area of paving executed in tramway streets between curbs is 576,297 superficial yards, and this work together with that of the permanent way, embracing 45 miles 6 furlongs 5 yards equivalent length of single line, has involved an expenditure of £574,814 14s. 4d.; added to this amount, the charges for incidental work, viz., £53,002 13s. 8d., makes the total expenditure for works in tramway streets, under all heads, £627,817 8s. The average rate of progress has been highly satisfactory, representing the construction of 1 mile of tramway and 13,402 superficial yards of impervious pavement per month, irrespective of the execution of the incidental works appertaining thereto. In addition to the 576,297 superficial yards of impervious pavement above alluded to, large areas of similar pavements have been executed in other streets in the respective townships of the city, embracing 432,106 superficial yards, making a total area of impervious pavements laid in the city during the six years now under review, viz., from 1879 to 1885, of 1,008,403 superficial yards, or an average of 168,067 superficial yards per annum.

The old materials which existed in the tramway streets have been utilised to the fullest extent, the Corporation executing the works by their own workmen, enabling them to deal with these materials most advantageously. The total cost of the work executed in the tramway streets, as given in the table, represents the cost, assuming that the whole of the old materials were in the first instance removed from the works and re-charged as utilised either to these works or to other paving works in the respective districts. The actual cost of the paving beyond statutory limits is less than that stated in the table by the value of these old materials, which is considerable.

"The Liverpool city lines as now laid, comprising a mileage of 47 miles 4 furlongs 133 yards, are conclusive proof that when tramways are well designed and properly constructed they do not form the slightest impediment even to the narrowest wheeled vehicles. The agreement with the Liverpool United Tramways, and Omnibus Company, the lessees of the Corporation tramways, provides that the basis of rental shall be as follows, viz:—7½ per cent. on £30,000, being the amount of purchase money for the original lines laid previous to 1879; 7½ per cent. on the cost of reconstruction of these lines; 10 per cent. on extension lines.

"From the table appended to this report it will be seen that the total expenditure upon the whole of the tramways constructed since 1879 has been £278,947 7s. 8d., to which amount has to be added the £30,000 paid for the original lines and also a portion of the law costs incurred, making a total expenditure for tramways and paving within statutory limits of £310,535 17s. 6d., and for all works in tramway streets a total expenditure of £659,405 17s. 10d. Upon the former amount the Corporation at present receive an annual rental of £29,053 17s. 10d. Owing to the superiority of the permanent-way of the "Lyver" system and the high-class quality of the materials and workmanship throughout, the cost of maintenance within statutory limits is reduced to a minimum. There is also the saving effected in the reduced cost of maintenance through having 576,000 superficial yards of the highest class of impervious pavement in lieu of the more or less defective carriage-way pavements which previously existed in the streets traversed by tramways.

"The carriage ways are excavated to a depth determined upon as the work proceeds by the depth of pitching or other hard foundation which exists underneath the original pavement. A bed of Portland cement concrete is then formed to within 7¾in. and 6⅛in. respectively of the finished surface of the street, and this concrete is carefully finished off to the exact cross section of the finished roadway. The concrete is composed of one part by measure of Portland cement, six parts by measure of gravel, and eight parts by measure of broken stone. The cement mortar is mixed as follows:—A cubic foot of gravel by measure is tipped on to the mixing board and a quarter of a cubic foot of cement by measure added; the two materials are then turned over with a shovel until thoroughly mixed and incorporated; sufficient water is then turned on through a rose and allowed to flow over the material, which is then constantly turned over, special care being taken that only sufficient water is added, so that the dampness of the material is such that when a small portion is taken in the hand and pressed it will only just adhere together.

"On the bed prepared for the concrete foundation moulded blocks formed with Portland cement concrete of about 8in. square at the base are laid with their upper faces on a level with the underside of the sleepers when the latter are fixed in position. The sleepers are then laid on these blocks, the rails being placed on them, and the wrought iron jaws secured to the rails and sleepers by bronze bolts and wrought iron nuts. A space of about a quarter of an inch is maintained between the upper surfaces of the jaws and the underside of the rail by means of temporary wrought iron split washers. The rails and sleepers having been correctly laid as regards level and position in roadway, gauge, &c., the concrete foundation is then proceeded with. After the foundation has become set, the bolts are unscrewed, the temporary washers removed, the bolts replaced, and the rails and sleepers firmly screwed down to the jaws, which have then become firmly bedded in the concrete foundation. The recesses or hand holes are then completely filled in with plastic pitch which surrounds the nut E, and thus prevents it from turning round. The jaws and fastenings are 3ft. from centre to centre, except at the ends of rails, where they are 9in. from centre to centre. The points and crossings are of annealed crucible steel, roughened on exposed surfaces, and secured to special cast iron sleepers in a similar manner to the Bessemer steel rails, except that a layer of roofing felt is laid between the points and crossings and their respective sleepers. The sleepers are filled with Portland cement concrete up to the level of the underside of the rails, and the recesses for the jaws filled with plastic pitch, completely surrounding and holding in position the wrought iron nuts.

"Between the rails, and for 18in. on either side of the same, the roadway is paved with syenite sets, the sizes varying according to circumstances, their description being as follows, viz., 3¼in. wide on the bed, 6¼in. deep, and from 5in. to 7in. in length, and 3¼in. by 7¼in., and from 5in. to 7in. in length; also block sets 3¼in. wide on the bed, 6¼in. in depth, and 3¾in. in length. The sets are squared throughout, accurately gauged, and laid in regular straight and properly bonded courses, and evenly bedded on a layer of fine gravel not exceeding ⅜in. in thickness. After paving, the joints of the sets are filled with perfectly clean and dry shingle passed through a ⅝in. riddle, and retained by a ⅜in. mesh; the sets are well rammed, and new shingle applied until the joints are perfectly full; they are then well grouted with hot pitch and creosote oil of the best quality; and, finally, the paving is covered with ⅜in. of sharp gravel. Along each side of the rail there is laid a course of alternate long and short syenite sets, accurately gauged, squared throughout, and specially dressed. These sets are finely dressed on the side abutting the rail, so as to touch it at all points, the top edge being accurately dressed so as to touch the rail for its entire with, and the base of the set bearing at its extreme ends on the bedding. They are also gauged so that the joints at right angles to the line of the rail shall touch for at least 1½in. along this joint, measuring from the rail.

"The prices paid for materials and labour are as follows:—

Bessemer steel rails, straight	£8 15 6	to £7 12 0 per ton.
,, ,, curved	Bent by Corporation workmen on the works.	
Cast steel fixed points..	1 6 9 per cwt.	
,, movable points	1 6 9 ,,	
Cast iron sleepers, straight	5 14 0 per ton	to 4 15 0 per ton.
,, ,, curved	6 0 0 ,,	5 5 0 ,,
,, ,, special	7 15 0 ,,	
Wrought iron holding-down jaws, double	0 14 3 per cwt.	
Wrought iron holding-down jaws, single	0 13 3 ,,	
Phosphor bronze bolts..	9 10 0 per cwt.	to 8 3 4 per cwt.
Wrought iron nuts	1 11 9 ,,	
Syenite sets, 3¼ × 6¼in. on quays ..	1 8 0 per ton	to 1 6 9 per ton.
,, 3¼ × 7¼in. ,, ..	1 7 0	
,, 6¼ × 3¼ × 3¾in. (block sets).	1 8 0 ,,	
,, specials	1 12 6 ,,	1 10 0 ,,
Shingle (on quays)..	0 6 3 ,,	0 5 6 ,,
Gravel ,, ...	0 5 0 ,,	0 3 10 ,,
Coal tar pitch	1 13 0 ,,	1 4 0 ,,
Creosote oil	2½d. to 1½d. per gallon.	
Coke	0 11 8 per ton	to 0 5 0 per ton.
Portland cement	2 0 0 ,,	1 19 0 ,,
Breakers	0 7 0 ,,	0 4 6 ,,
Burr pitching..	0 2 6 ,,	0 2 0 ,,
Broken stone	0 5 6 ,,	

NOTE.—The above prices were for delivery on the works free of all charges, except where otherwise stated.

Rates of Wages Paid.

	Piecework.	Day work.
Platelayers		5s. 4d. to 5s. per day.
Blacksmiths		5s. ,,
Paviors	Outside tramway limits, inclusive of all labourers' work, from the completion of the finished surface of the concrete (with the exception of pitch carrying, for which one penny extra per yard is allowed), 5½d. per superficial yard. Inside ditto ditto, 9d. per superficial yard..	5s. 4d. ,,
Masons	Flagging laid complete, inclusive of all labourers' work, 6d. to 1s. per superficial yard. Curbs, channels, &c., ditto ditto, 4d. to 6d. per lineal yd.	6s. to 5s. 6d. ,,
Set dressers..	Ordinary sets, 7s. 6d. per ton .. Small ,, 11s. ,, .. Special ,, 16s. ,, ..	6s. ,,
Platelayers' labourers..		4s., 3s. 6d. ,,
Paviors' and masons' labourers		4s., 3s. 6d. ,,
Ordinary labourers		4s. 4d. to 3s. ,,
Watchmen		3s. 4d. ,,

"Owing to the number of lines crossing each other at the Old Haymarket, viz., Manchester-street, Byrom-street, St. John's-lane, Great Charlotte-street, and Victoria-street lines, the engineer considered that it was advisable to make some arrangements by which the tramway traffic could be safely controlled, so as to minimise any liability to accidents at the intersection of these six thoroughfares which converge at the Old Haymarket, the foot traffic and general vehicular traffic at this point being exceptionally heavy. With this object in view he decided to fix a pointsman's cabin, from which the signals and movable points of the tramway lines are worked, upon the same principle as those upon which railways are worked. Messrs. Saxby and Farmer, railway signal engineers, Kilburn, London, N.W., have worked out the details of this arrangement in a most complete manner. They have been in operation since March, 1883, and continue to work satisfactorily.

"From a return the engineer has received from the Liverpool United Tramway and Omnibus Company, the lessees of the lines, it appears that tramcars running on ten different routes in the city pass over these points, the number on an ordinary working day being 111 cars passing the points 1190 times. Taking a typical half-hour of the day's working, an average of about forty-five cars pass the cabin during this period.

"The engraving—page 392—shows a plan of the junction at the Old Haymarket, with the position of the pointsman's cabin and signal columns on the pavements, the dotted lines showing the direction of the point rods and signal wires, also a sectional side elevation of the signal and point levers, cast iron boxing, rocking shaft-box, point, and signal column. The pointsman's cabin is placed at the junction of the tramway lines at the Old Haymarket, St. John's-lane, Great Charlotte-street, Whitechapel, Victoria-street, and Manchester-street, from which movable points are worked, and interlocked with semaphore signals fixed on the footpaths by means of rods laid in underground tubes, and actuated by levers fixed in the pointsman's cabin. The movable points are of the usual type employed throughout the Liverpool tramway system, viz., a crucible cast steel point with a Bessemer steel movable tongue, and to the narrow end or "nose" of the point-tongue is attached a bolt ⅝in. in diameter, working through an oval aperture in the fixed steel point, the other extremity of the bolt being attached to a small horizontal crank. This crank is secured to a vertical rocking shaft fixed in a cast-iron box, with a surface lid of roughened cast steel adjacent to the point. On the lower extremity of the vertical rocking shaft is fixed a crank similar to the one at the top; to this crank is fixed a ⅝in. diameter wrought iron rod, which is laid direct to the cabin by means of cast iron tubing laid under the carriageway, and carrying the rods on cast iron trunnions placed at intervals of six feet apart.

"The point rods are attached at the cabin to the interlocking apparatus. The signals are of the automatic balance semaphore type, with enamelled wrought iron arms, bulls-eye gas lanterns, and coloured lenses. They are worked from the cabin by means of steel wires, single strand, No. 12 B.W.G., laid in thimble fixed in the same tubes that the point rods are laid in. They are connected to the semaphores and the interlocking apparatus in the cabin. The pointsman's cabin contains a frame of fourteen levers, nine being connected with the signals and five with the points. They are patented by Messrs. Saxby and Farmer, and are known as three-quarter size. The whole of these levers are interlocked in such a manner that no two sets of lines which run into each other could be both signalled open at the same moment. This is imperative to the safe working of the lines, and all depends on the proper adjusting of the locks, it being then impossible for a wrong lever to be pulled over. Again, should a wire break, the semaphore that it is in connection with flies to 'danger,' being actuated by a weight on a horizontal arm, at the base of the single column, and remains at 'danger' until the proper connection is reinstated."

THE PROFESSOR IN THE MACHINE SHOP.

IT is not necessary to agree with every detail before admitting that there is a good deal of truth humorously put in the following from the pages of the American *Mechanical Engineer*:—

"I suppose an old fellow like myself, whose sands of life are fast running out, may say a word without offence on some aspects of these modern schools for making machinists, and I hope no one will feel that I am intruding advice unasked, or that I put forward my views unnecessarily, because I think there is a chance for our young friends at school to take a leaf out of my book. This is the same old book we are all learning from—experience—and though it is as dry as dust, it is not unprofitable. A lamentable feature connected with this work is that young men will not read it, and the old men are always adding to it, and though it is an unfinished work the wisest may gather new inspiration from it daily and hourly. What price will buy experience? Fair wages to the man who has it, but the purchase of it outright—that is another matter. A man cannot part with it if he would, except in parcels; never in fee simple.

"Thinks I to myself, last week, I will go into one of these schools which I happen to know of in a city not far distant, and see with my own eyes what is going on, and how our young friends are making out. Acting on this idea, I presented myself at the school, and was at once admitted. 'I see you are a machinist yourself,' said the gentleman in charge. 'How do you see that?' said I; 'it is a fact which I was endeavouring to conceal.' 'I felt the "file-handle callous" when I took your hand,' said he, knowingly. 'Did you?' said I, 'You might have felt the same callous on a wood turner's hand; how would you distinguish in that case?' 'Well, I couldn't,' said he, and we went into the shop. It was not very full of students at the time, only fifteen or twenty, I think, but they made up for lack of numbers by their enthusiasm. We came to a lathe where a young man was turning off a piece of cast iron, about 6in. in diameter, by 24in. long, in an 18in. lathe; that is a lathe which swings 18in. over all. The student was sitting on the tool board on the lathe shears, and his tool had a very light cut indeed, and a very slow speed on the lathe.

"'What is this young gentleman trying to do?' said I. 'He is learning to turn cast iron,' said my friend. 'Is it in order for me to offer any suggestions?' said I. 'Why certainly; we would be glad of any hints you can give us.' 'Well,' said I, in a low tone, so as not to offend the young gentleman if he overheard me, 'I would give him a gentle hint to get off the tool board if he was in my shop, and rest himself on his feet; how would he like that do you think?' 'Not very well, I am afraid,' said my guide, smilingly. 'The students don't care to undergo any more discipline than is needful, and the rigid demands that would be made upon them in the shop would not be complied with.' 'Oh!' said I. 'How about the speed and feed on this job? It appears from what I see—I can't judge by anything else, you know—that our young friend is in training for a "sojer." I used to do this once myself, so I know,' said I, jokingly. 'Oh, he is only just learning,' said my friend. 'How long has he been learning?' 'About a month.' 'And he knows all about setting tools, grinding them, forging them, speeds, feeds, &c., already?' 'Oh no,' said the guide, 'Jenks don't know the half of that; you radicals want to put a young man ahead too fast.' 'So far as I can judge,' I said, 'Jenks isn't learning anything, except the sober jog trot of a man nursing his job. Did Jenks ever break this lathe?' 'No,' said the guide, 'only once, when he got mad at the tool, and tried to knock the tail of it around with his hammer; then he hit the set screw in the tool post instead, and broke it off.' 'Well that's all right,' said I. 'I am glad he did; he learned something by that. My idea is that Jenks should just jump that lathe for all it is worth. He ought to be told to put on such a cut that the belt wouldn't carry it; that it would run off and get caught in the back gear, cut all up, and finally pull the counter shaft down overhead if he did not look out. He ought to put on such a cut that the centres wouldn't carry it, then the work would jump out, fall on the saddle of the carriage and break it right in two.' 'Is that the way you learned the machine trade?' said my friend, laughing. 'Partly,' said I. 'I learned what not to do by doing some very bad things, and seeing others do them. If Jenks breaks the lathe, he is an awful example, and not he alone but all others in the shop at the time take a leaf out of his book, and learn what not to do. I learned never to slam a belt shipper hard back violently once by seeing a man next to me do that same thing, and actually jump the counter shaft out of the hangers by it. It came down on the shears close by him. A slight accident in a shop goes a long way, my friend, for it is a warning to every man in the place.'

"But if I go on with this detail I shall never describe what I saw. In our journey around we found young men in the tool room, giving out tools to applicants, wherein the same routine of checks was observed as in regular shops; we found young men running planers, planing imaginary jobs, or pieces, with flats and squares on them that were executed solely for practice on this tool. We found others filing with greater or less enthusiasm, success, and perspiration, and, passing below, found still others working at the forge, dressing tools, or striking for the blacksmith, as in regular shops. In the foundry we saw young men moulding, and in the store room we saw the results. These were not flattering, and my guide said that it was not expected of the young students that they should turn out perfect work, but that they could learn by failure as well as by success. 'Ah,' said I, 'that is a great truth; if they only learn the success with the failure. One is as necessary as the other. If a young man makes a mistake and the instructor points out to him the cause, then the young man must go to work and make a good job, leaving out the cause of failure. Am I not right?' 'You are quite right,' said the guide, 'but you must know that we do not profess to make mechanics, but merely to fit young men to be mechanical engineers, so that they may know how to direct work and see when it is properly done.'

"I had a notion to ask my friend if he believed that a part was greater than the whole, or how a man with a few hours' daily amateur labour, extended over a few years, could tell a man who had worked at the trade, say twenty years, whether his work was properly done or not; but foreseeing an argument, I held my peace and came away with many thanks for the opportunity given me. After I got away from the place I thought that I must have outlived my usefulness, and never so fully realised that I was getting old. Here is a new order of things established, said I, and I shall never live to see whether the inferences I have drawn, or opinions I have formed, are erroneous or correct. All this set task work, all this routine without useful object, all this fitting nothing to nothing and daily work that results in nothing, has no commercial risk involved, and no 'discharge' penalty attached if it is spoiled, seemed to me the dreariest and most profitless spectacle I had witnessed in many a day. All the tools looked so new, so tenderly handled, so just out of the shop, and wore such a holiday aspect, that I longed to see somebody at work upon a lathe with a bed like a railroad track, turning out a first class job. I would have shaken hands with an old bolt cutter—with three threads in each die and the outside ones stubbed off like the teeth of an old dog—turning out bolts; not the best in the world, but still bolts that would hold, and serve a purpose. There were gauges, micrometres 'never-miss-the-size' appliances of all kinds in the tool room, and every sort of 'now-I've-got-you' rig, that had been invented, but all these things seemed to me out of their proper places, or in the hands of those who could not appreciate them, but looked upon them as so many short cuts to save labour, instead of means to an end. I would have much rather seen the first room in this school devoted to weather-beaten and battered old tools of half a century ago—old fashioned appliances, such as the back breaking stock and dies that mumbled threads on bolts and made thews and sinews on the loins and arms of the worker that Ajax would have been proud of. The old chain planer whose bed went back and forth with a jerk that would knock a man off his feet should have had a place, and a youth should have been stationed at it, and bidden to plane a square foot of boiler iron on it so that the dimensions would be equal on all sides, and in the middle, with nothing but taper stake wedges, and a bed like a cobblestone pavement to fasten it to. And there should have been a cheerful screw cutting lathe, used alternately for cutting threads and chucking short pieces and with a lead screw like a cider press screw. On this a youth should learn to cut threads 24 to the inch, on ½in. rods for about 6in. long, just for fun, and without any cursing. If he could do all this in course of time, say in a couple of years, he might be pardoned from the machinists' purgatory and go into that heaven of good tools, the modern shop. Then he would appreciate what they were, and learn more from a mere inspection of their beauties than he will now from actually working on them. A man who is always well cannot tell what it is to be sick, or how it feels; and one who has always worked on good tools is lost on bad ones. Yet there are bad ones to-day, and in the hands of those who know their business can do work—at a loss. In a word, this school for giving young men an idea of what the machine business is like, seemed to me to be a mere holiday experiment, which had its rise and origin in the minds of theorists who never had done a hard day's work in their lives, and who knew not the moral discipline of the ratchet-wrench.

"There is no connection in this paragraph, says some objector, or between the subject and the conclusion. I must differ—there is, but a man must pull the connection out by the handle of the ratchet-wrench, as I have, or he never will see it. Set a young man to work on such a job, let him be cold, hungry, sleepy, and poorly paid, and, if there is the making of a man in him, he will register a vow then and there, that he will rise higher, so that he will be too valuable to be put on such routine work. The methods of the schools lack the hard, grinding task work, which makes a man fertile in resource, quick in emergency, and with tremendous physical energy and pluck to over-ride all obstacles. In so far they fall short, but I will not deny that they supply correct principles, educate young men in branches which the ratchet-wrench never heard of, and lay a foundation for future usefulness which—if the individual will grasp it—will stand him in good stead when he tackles life *in earnest.*"

METHOD OF STATING RESULTS OF WATER ANALYSES.

THE Chemical Society of Washington, at the meeting of November 12th, 1885, appointed a committee to consider the present state of water analyses, and to present a method of stating analyses adapted for general use, in order that those hereafter published may be readily compared with each other and with future work. This committee reported February 11th, 1886, and was authorised to prepare an abstract for publication, in order to call the attention of chemists to the subject. The Society earnestly recommends the adoption of the scheme, which is herewith briefly presented. The full text of the report will be published in the next bulletin of the Society.

Water analyses are usually made to answer one of three questions, viz.:—(1) Is the water useful medicinally? (2) Is it injurious to health? and (3) Is it suitable for manufacturing purposes? Many books relating to water were published during the eighteenth century, but accurate chemical analysis was not attempted until about 1820. As the earlier analyses were isolated, rare, and made for special purposes, the form of the statement was of little importance, if it was only intelligible. At the present time, however, water analyses are very numerous. An examination of about a thousand shows some forty-two methods of stating quantitative results, there being sometimes three different ratios in the report of one analysis. Such discrepancies render comparisons difficult and laborious.

The various methods of statement may be classified under the following general forms:—(1) Grains per imperial gallon of 10 lb., or 70,000 grains. (2) Grains per U.S. or wine gallon of 58,372+ grains. (3) Decimally, as parts per 100, 1000, 100,000, or 1,000,000. (4) As so many grams or milligrams per litre. The last two would be identical if all waters had the same density; but as the densities of sea-water, mineral waters, &c., are much above that of pure water, it is plain that the third and fourth modes are not comparable.

The committee therefore unanimously recommends—(1) That water-analyses be uniformly reported, according to the decimal system, in parts per million, or milligrams per kilogram, with the temperature stated, and that Clark's scale of degrees of hardness, and all other systems, be abandoned. (2) That all analyses be stated in terms of the radicals found. (3) That the constituent radicals be arranged in the order of the usual electro-chemical series, the positive radicals first. (4) That the combination deemed most probable by the chemist should be stated in symbols as well as by name.

The abandonment of Clark's scale has been recommended by Wanklyn and Chapman; and the recommendation made by the committee does not involve the disuse of his method, but merely the bringing of it into accord with the decimal system—the changing from grains per gallon to milligrams per kilogram. The last conclusion—No. 4—was deemed desirable from the frequent confusion in the statement of the iron salts and of the carbon oxides. The committee is unanimous in the opinion that analyses in the form recommended will prove quite as acceptable to boards of health and to the public in general, for whom such analyses are often made, as if presented in the mixed and irregular forms commonly adopted. The committee also feels sure that the people in general are better able to form a definite idea of the character of a water from a report stated in parts per 100, parts per 1,000,000, &c., than from one expressed as grains per gallon, the latter being a ratio wholly unfamiliar to any but those in the medical or pharmaceutical professions.

THE PANAMA CANAL.—M. Rousseau's report, according to the *Temps*, is unfavourable to the Panama Canal Company as regards the difficulty of the cutting, the sum still required to complete it, and the time necessary. The Government has therefore asked the company to reply to these objections, and meanwhile the lottery debenture scheme will remain in suspense.

THE SEVERN TUNNEL.—Some very fine photographs of the two entrances to the Severn Tunnel have been taken, and are being published by Mr. F. H. Worsley Benison, of Livingstone House, Chepstow. We have received a very fine carbon picture, 24in. by 18in., of the English entrance, and a pair of permanent platinotype pictures of both entrances, 11½in. by 9½in. They give a good idea of the bold character of the work, and are of very great interest to all engineers. The leading particulars of the tunnel are given with each picture.

THE CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—The annual dinner of this Society took place in the Holborn Restaurant on Wednesday evening, the president, Mr. H. Michell Whitley, being in the chair. About forty members and visitors sat down and passed a very pleasant evening. The Society is a small but vigorous one, and in its sphere as supplementary to the larger institutions, performs a most useful part in providing the means of discussing technical subjects and of making useful professional acquaintance, often of great service to the members generally and the younger ones particularly.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, May 8th.

TO-DAY'S telegrams from some twenty points throughout the West show that the labourers' movement for shorter hours and higher pay has been generally successful. The opinion has been expressed in well-informed circles that this agitation will continue throughout the summer and autumn, and probably do a great deal of harm to new projects which are coming to the surface. Several railroad companies have borrowed between 50,000,000 dols. and 60,000,000 dols. within the past four or five weeks for projected lines. Everything is in good shape for a general improvement in trade and an increase in manufacturing demand, and manufacturers and all others are, therefore, extremely anxious that the present unsettled condition of labour should be disposed of promptly. Concessions are being generally made. In a few cases employers are resisting the eight hour demands for ten hours' pay. The organisation of capital continues in several branches of trade. Employers in the brass-making industry, representing 10,000 workmen, have completed their organisation on the basis established by the Rhode Island manufacturers. Other organisations are under way, and it is quite probable that during the coming summer manufacturing capital throughout the United States will be pretty well organised for defensive purposes. A strong public sentiment is growing up against the extreme policy of labour organisations in boycotting. Several Bills have been presented in Congress for the arbitration of difficulties, but it is probable that none of the contemplated legislations will be satisfactory.

A great deal of business is hanging fire. Locomotive dealers report the holding back of expected business in the West and South-west. The Baldwin Locomotive Works, who six years ago were making only four locomotives a week, and who within the past four months have been making twelve, have been disappointed in expected orders, which would keep them running at that rate all the summer. The same report is made by the managers of other locomotive works in New Jersey and New York.

As yet the managers of car building works have met with very little disappointment, because of the urgent need of rolling stock of all kinds.

The merchant iron mills of New York, New Jersey, and Pennsylvania are running full time, and the plate, bridge, and sheet mills have enough business to carry them up to June 15th at least. The nail factories west of the mountains are idle with the exception of about 1000 machines, and there are no probabilities of a general resumption. The Eastern factories are running full time. Quotations are 2.20 dols. to 2.40 dols. Scotch iron is selling slowly. Inquiries are in hand for Bessemer pig and spiegeleisen. Large quantities of foreign ore are arriving, and the domestic sources of supply are being worked vigorously, to meet the very heavy demand.

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

(*From our own Correspondent.*)

A SLIGHTLY better demand is this week apparent for some classes of finished iron on home account. The damage wrought by the recent floods in various parts of the kingdom has occasioned a little increased inquiry for iron for bridge building, roofing, and some other constructive purposes. Simultaneously quickened demands for galvanised roofing sheets, &c., are being made on account of Spain to repair the havoc wrought by the hurricane in Madrid.

This week's Australian mail is the most favourable which has arrived for some time. Stocks of galvanised iron have been greatly reduced, causing prices to advance.

Local iron consumers engaged in the hardware trades are buying steadily, and some ironmasters who mainly depend upon this class of customers are quite active. Generally speaking, however, the current supply, although curtailed, is much in excess of the markets' requirements.

The demand for hoops and strips is maintained better than for some other descriptions of iron, and certain of the hoop firms have no lack of business, and are running pretty full time, the orders being divided over export and home buyers alike. United States buyers are pressing orders upon the market for baling and cotton tie hoops, since the shipping season is now getting considerably on. The iron mills of Warrington, Wigan, and other localities nearer Liverpool, and likewise the mills of North Staffordshire, are securing most of the business; still, Messrs. Downes and other Staffordshire houses are getting a share. The American buyers are only giving low prices. Gas tube strip for local consumption is going off at £4 17s. 6d. and upwards.

Makers of thin sheets for stamping purposes and of superior tin-plates are much better off for orders than makers of ordinary and common sheets. They are experiencing a good export demand on account of the Australias, Canada, the Continent, and elsewhere. Working-up sheets are quoted by the chief houses at £10 to £10 10s. and on to £11, while stamping sheets are quoted £11 to £12. Steel sheets are quoted £11 to £12 10s.

The state of the galvanising and general merchant sheet trade is sufficiently indicated by the circumstance that Messrs. Harris and Jeavons, Britannia Ironworks, have determined to follow the example of some five other sheet firms, and close down for a while. Messrs. Groucutt and Sons, of the Bankfield Ironworks, Bilston, have now paid off their operatives and shut down the works. They declare that they cannot continue manufacturing at present selling prices. The only inducement which is likely to influence the firm in restarting at an early date would be an offer on the part of the ironworkers to accept a reduction of wages. The effect upon the market should be to gradually strengthen prices. Buyers, however, still find the supply of sheets ample for all their requirements, and will not be easily persuaded into giving more money. Sheets of 24 w. g. are £6 to £6 5s., and a few makers ask £6 7s. 6d. For 27 w. g. 15s. to £1 per ton extra is being obtained. Marked bars are in rather better demand at £7 per ton. Second-class branded bars are £6, and merchant bars are worth about £5 10s., but sales are effected at £5, and in some cases at £4 15s. Tank plates are easy at £7 and upwards, and boiler plates at £8 to £9. A better business is doing in steel of all sorts, but prices are discouraging.

Messrs. Nettlefolds are pushing forward the erection of their new works at Newport, to which they will transfer their iron and wire rod making business from Shropshire.

Messrs. A. Baldwin and Co. are progressing with preparations for the erection of their new works for superior tin-plate manufacture at Panteg, near Newport. They have taken some twelve acres of land, and over eight acres are understood to be available to them if by-and-bye extensions should be needed. The company hopes to have an output of something like four or five thousand boxes a week.

Messrs. Parkes and Parkes, who some time ago acquired the works at West Bromwich, formerly run by the Eagle Coal and Iron Company, are proceeding slowly with preparations for converting the works at which angle iron was formerly manufactured into sheet works. It is expected that ultimately four sheet mills will be laid down.

The pig iron trade is still backward. Quotations for hot-air mine pigs range from 57s. 6d. to 52s. 6d. per ton, whilst transactions have taken place at lower figures. Cold-air iron commands about 77s. 6d. per ton; part-mine, 35s.; and common iron, 27s. 6d. to 30s. per ton. Northamptons are 34s. per ton upwards delivered to railway stations here. Hematites have fallen 2s. 6d. per ton since the quarterly meetings. Excellent Welsh brands are now quoted 50s. delivered here.

The newest feature in the North Staffordshire iron trade is the conversion of the Shelton Bar Iron Company, Stoke-on-Trent, of which the Earl of Granville is the chief proprietor, into a private limited liability company, the subscribers being noblemen and gentlemen, friends of Lord Granville. The capital is a quarter of a million sterling, in 250 shares of £1000 each, and the company will issue, as a consideration to the co-partners, shares considered as paid-up to the extent of 75 per cent. It is interesting to note that the chief shareholders now figure as the Right Hon. Earl Granville, who owns 77 shares; the Hon. E. F. Leveson-Gower, 22 shares; G. G. Leveson-Gower, M.P., 5 shares; the Right Hon. Baron Wolverton, 20 shares; the Most Noble the Marquis of Lansdowne, 8 shares; the Right Hon. Earl Spencer, 8 shares. Only 200 of the shares are at present being issued. This is the North Staffordshire concern which I recently announced as intending to lay down a new basic steel plant.

The recent alteration in South Staffordshire prices does not materially affect the prices in North Staffordshire. These remain as they were previous to the South Staffordshire alteration, but in actual business prices are still on the decline, and plates, for instance, show a fall during the last couple of months of 5s. per ton. Messrs. Robert Heath and Sons, of the Biddulph Valley Works, now quote, f.o.b. Liverpool: Ordinary bars, £5 10s.; best, for shoe and turning purposes, £6; double best, £7; angles and tees, £6; best angles, £6 10s.; while best tee iron is £6 10s.; Ravensdale hoops are £6 10s. to £6 15s.; best half round and convex bars, £6; bridge or tank plates, £6 10s.; best boiler plates, £7 to £7 5s.; double best, £8 5s.; and treble best, £10 5s.

Messrs. Kinnersley and Co., Clough Hall Ironworks, Kidsgrove, quote, f.o.b. Liverpool:—Bars, £5 2s. 6d.; best, £5 12s. 6d.; and double best, £6 12s. 6d.; angles, £5 7s. 6d.; best, £5 17s. 6d.; and double best, £6 17s. 6d.; tees, £5 12s. 6d.; best, £6 2s. 6d.; and double best, £7 2s. 6d. Bridge and tram rails they quote £5 7s. 6d.; half-round, convex, and oval bars, £5 12s. 6d.; and triangular iron, £6 2s. 6d. These works are, however, just now at a stand in consequence of the dispute with the operatives. The firm have served a notice for a 10 per cent. reduction because of the unprofitableness of present prices, and the men have declined to accept any drop.

The engineers and machinists have some fairly satisfactory export orders to execute, while railway ironwork for various English and colonial lines commands a regular custom. The constructive ironwork and heavy ironfoundry people are steadily engaged. An attempt will be made to secure for this district some of the engineering work which the East India Railway Company has just now upon the market, and which includes pumps and boilers, portable forges, locomotive steel tires, and the like. The supply of wheels and axles and axle-boxes needed by his Highness the Nizam's State Railway for the 5ft. 6in. gauge line may also possibly go from this district. Gaswork engineers are some of them tendering for the set of four purifiers needed by the Kettering Gas Corporation.

The South Staffordshire and East Worcestershire nailers are still agitating for an advance in wages. A deputation on their behalf waited to-day upon Mr. Green, chairman of the Employers' Association, at Cradley, and urged him to call a masters' meeting with the view of an advance of wages being given to the operatives, many of whom, they stated, are now undergoing privations through submitting to a series of reductions. Mr. Green sympathised with the operatives, but could not see his way clear to call a meeting at present.

The West Bromwich Corporation have, after considerable negotiations, secured from the Local Government Board the powers necessary to raise the £5000 required for the establishment of the new gasworks, but the restrictions which the Board have attached to these powers are such as to render the scheme impracticable. A meeting of the Town Council was held on Friday, when the report of the Gas Committee suggesting alterations in the provisional order was adopted, and it was decided to urge upon the Local Government Board the desirability of the amendments being sanctioned.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The condition of the iron trade throughout this district remains practically unchanged; it is still lacking any sign of improvement, and the actual business doing continues of the most meagre proportions with prices cut quite as low as ever. The current market prices are no lower than the minimum rates that have recently been quoted, but it can scarcely be said that absolute finality has yet been reached in the way of concessions. When there is an order of any importance to give out, buyers, no matter how low the price they have previously induced makers to accept, persistently press for some further concession, and although there are some makers who prefer to remain practically out of the market rather than follow constantly receding prices, which mean only an increasing loss to themselves on every succeeding transaction, the necessities of others apparently compel them to seek after business on such terms as it can be secured. This continued want of firmness shown by some sellers checks any disposition on the part of buyers to give out orders beyond what they are absolutely compelled to place, and so far as some of the consumers are concerned, they are not only altogether out of the market for any present requirements, but they are suspending deliveries of iron on account of contracts they have already running.

An inanimate tone again characterised the iron market at Manchester on Tuesday. There was a fair average attendance, but very little business offering, and I could hear of no transactions of any weight being recorded. For pig iron the demand was extremely slow, and where buyers had orders to give out they could place them in district brands at about 35s. 6d. for forge and 36s. 6d. for foundry, less 2½ per cent., delivered equal to Manchester. These may be said to remain about the minimum figures in the market; Lancashire makers still ask 37s. to 37s. 6d., less 2½ per cent., delivered here, and about the same is also still quoted for one or two Lincolnshire brands, but it is only occasional small special lots that are sold on the basis of these prices, and practically they are out of the market so far as ordinary business is concerned. For outside brands offering here prices also remain very low, with, if anything, an easier tone in some instances.

Hematites still meet with little or no inquiry, and the excessively low prices which have been quoted for some time past apparently offer no inducement to buyers. Lancashire No. 3 foundry hematites can be bought at 49s. 6d., and Cumberland brands at about 50s. 6d., less 2½, delivered into this district.

The manufactured iron trade remains in much the same position as last reported; there is still only a very slow hand-to-mouth business doing, with forges in most cases only kept partially employed, and prices are cut extremely low to secure orders. The average current prices are about £4 17s. 6d. to £5 per ton for bars, £5 7s. 6d. for hoops, and £6 10s. for sheets, delivered into the Manchester district; but these do not represent the minimum figures which are taken in some instances where sellers are hard pushed.

In some branches of the engineering trade rather more activity seems to prevail. Several of the large firms engaged on heavy engineering and millwright work are reported to be better supplied with orders than they have been of late. Tool makers and machinists, although they can scarcely be said to be any busier generally, are in the leading shops fairly off for work. The demand for labour would also seem to show a slight improvement throughout the district, and the last reports of some of the leading trades union societies connected with the engineering branches of industry show, if anything, a slight change for the better in the condition of employment throughout the country generally. It will be of interest if I here summarise a few particulars I have been able to glean from these reports. Although none of the reports from the important centres of industry record any distinct or appreciable improvement in the actual conditions of trade, there is a decrease in the returns of the number out of employment, which, if only small, is so general in its character that expression is given to the hope that trade is at length slowly recovering from the long protracted depression. The returns of the Amalgamated Society of Engineers, although the general tenour of the reports from the various districts is still that trade is bad, show a slight decrease upon those of the previous month in the number of members in receipt of out-of-work support; this decrease is pretty evenly distributed throughout all the large industrial centres of the country, and the number on the books in receipt of out-of-work support, which last month stood at about 10 per cent., has now got down to about 9 per cent. of the total membership. The report of the Steam Engine Makers' Society states that the slight improvement shown in the last report is maintained, the number of unemployed has again decreased, whilst in many of the districts a rather more cheerful tone was manifest, and they were in hopes that the worst was now past. The evidence of actual improvement was, however, not very great, and was apparent more in the smaller than in the large industrial centres, but the report does not regard this as any really discouraging sign, as, in all past depression, it adds, the ultimate improvement had not been prominent until they had found themselves in the midst of briskness. In the above society there has also been a decrease of about 1 per cent. on the total membership in the number of out-of-work members, the number in receipt of unemployed benefit having fallen from 6 to about 5 per cent. The unquestionable improvement in the condition of American trade shown in the various reports from the United States is also regarded as a very hopeful sign, although the general upset caused by the strikes affords ground for some apprehension as to the future. On this question a well-informed working man correspondent, whose forecast which I quoted from a previous letter has proved pretty accurate, writes that trade is looking up in the United States, and they expected a very busy summer, unless it were affected by the strikes that were now taking place in the country. "By present appearance," he adds, "the country is wild with strikes from one end to the other, for shorter hours and increased wages."

Messrs. R. and J. Dempster and Co., of Newton Heath, Manchester, on Tuesday produced something like a sensation in the principal streets of the city by the despatch of an exceptionally large consignment of gasworks plant. This consisted of girders, roof work, retort fittings, hydraulic mains, purifiers, valves, woodgrids, gasholder and other kinds of constructive work, weighing altogether about 150 tons. Owing to the absence of a railway siding at the works, this heavy weight of material was conveyed on upwards of fifty drays, which formed a continuous line of nearly half a mile through the streets to the railway station for despatch to gasworks in various parts of the country.

Messrs. Dempster, although chiefly engaged on gasworks plant, do not confine their attention by any means to this one branch of engineering, and they have just introduced a new patent Indian grain washer and drier, the invention of a practical miller and milling engineer in this district. The arrangement of this apparatus is very simple, and the grain to be cleaned goes through a continuous process without manipulation by hand. The grain is first passed into a sieve dickey, which takes out the loose dust, small seeds, and other foreign substances larger than the wheat, and from this it is made to flow over a magnetic roller which frees it from metallic substances, and after passing through an aspirator which removes all chaff and fibrous substances, it proceeds direct to a cylindrical washer. This machine is provided with a double set of agitators, which take hold of the grain and wash it thoroughly, and at the bottom of the washer is a receptacle, into which stones or any other heavy particles fall by their specific gravity. The washed grain is next made to pass up an inclined rinser, and in its upward course meets a downward flow of clean water, which divests it of any remaining impurities. At the bottom of the rinser there is an automatic mud extractor, which allows the heavy mud and fine grit to pass away; the water then rises vertically, and in its course carries away the light inferior and weevilled grain, smuts, &c., which finally pass off along with the dirty water through an overflow pipe. From the rinser the grain is conveyed to a hydro-extractor, in which the wet grain falls to the bottom, whence it is raised perpendicularly by an ingenious method, which, together with a centrifugal force that is exerted, leaves the grain almost dry. If desired, the grain can be taken direct from the hydro-extractor into sacks, or by means of a wing valve its course can be turned into a patent fire-proof iron elevator, and lifted into a drying machine fitted with a number of wrought iron steam jacketted tables, over which it is made to travel by means of revolving scrapers until it reaches the bottom, whilst an exhaust fan connected with the top of the machine draws in air from the bottom, which in its passage through the machine becomes heated, and absorbs the steam and moisture generated by the hot tables in the drying process. The dry air, which is drawn through a collar at the bottom of the machine, also tempers and conditions the grain ready for immediate use or storage.

In the condition of the coal trade there is no material change to report. The demand generally is very quiet, with supplies of all classes of fuel, except best slack, plentiful in the market, and prices if anything weak, although not quotably altered from those given in my last report.

Barrow.—There is not much change to note in the condition of the hematite pig iron trade, but the events of the past week have more than ever established the tendency there has been for a few weeks past in the direction of improvement and consolidation in the demand for pig iron, not only on home but on colonial and general foreign account. The inquiry, in fact, is very strong from all quarters, and the wants of consumers are shown to be very numerous; but the great drawback to the full acceptance of this improvement is to be found in the inability of makers and buyers arrive at such a basis of prices as will under present circumstances be mutually acceptable. The work in the hands of makers of iron is comparatively large when regard is paid to the position which they have occupied in an industrial sense for some time past; but their books could easily be well covered with orders if they cared to book large deliveries at present quotations. They are, in fact, putting up values, while buyers are endeavouring to secure both forward and prompt deliveries at even lower quotations than are ruling. This it is evident they will be unable to do. Steel makers are well off for orders for steel rails, and their works are well employed, and likely to be for a few months. Prices are steady at £3 16s. per ton net at works; indeed, makers are asking under this money, although continental makers are booking orders at as low as £3 10s. per ton. It seems probable that some very large consignments of rails will be sold in a few days. Shipbuilders quiet. Iron ore slow of sale. Coal and coke steadier. Shipping better employed.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE two armour-plate firms have just booked further orders from the Government. Messrs. John Brown and Co., Atlas Works, have obtained the order for the side armour for the Immortalité, and Messrs. Charles Cammell and Co., Cyclops Works, the side armour for the Aurora. These "lines" come in very acceptably, to take the places of other work now being completed. In another of the heavy departments a leading local firm is so fully employed that, in addition to the night shifts, seven days have had to be worked, and it is probable that the Sunday labour will be continued for a time.

The disastrous floods of last week did great damage to the iron furnaces, steel works, mines, and other places in South Yorkshire. At Sheffield the most serious loss was at the Brightside Steel Works—Messrs. William Jessop and Sons—where 350 men were suddenly thrown idle by the flooding of a portion of the furnaces. At Thryberg Hall the colliery was set on fire in a curious manner. The water rushing down the cupola shaft, where the furnaces were fixed, reversed the ventilation, and sent the flames in the direction of the down-cast shaft, setting fire to the conductors and woodwork at the bottom. Fortunately the men were got out in safety, but the fire was not extinguished before much damage was done. It is estimated that 7000 hands were thrown out of employment temporarily by the floods.

A serious difficulty has arisen in the edge tool trade. Messrs. Ward and Payne, who are the largest makers of edge tools in the world, have found of late that the Germans have been steadily encroaching on their markets. To meet this competition they deemed it necessary to reduce prices, and with this view requested their workmen to concede a reduction of 15 per cent., or alter their system of working by applying the principle of the division of labour to their employment. This they declined to do, and the firm thereupon advertised in Remscheid for German grinders to take their places. They first offered the situations to their old workmen, none of whom applied for them. They then filled up a few vacancies from outsiders, and have now intimated that unless they can get the workmen to accept their terms, they will most certainly bring over German grinders, many of whom have offered their services at considerably lower wages for much longer hours. The men, it is expected, will resent, and resist what they call the "foreign invasion," which has excited no little sensation among Sheffield workmen generally. Messrs. Ward and Payne, it may be mentioned, have recently adopted a machine for forging edge tools, by which production is immensely increased and cheapened.

The Sheffield sewage works, for which £150,000 have been borrowed, are now completed, and are to be formally opened on June 2nd. Mr. Gott, C.E., formerly of Bradford, was the engineer for the construction of the sewerage scheme, and Mr. Alsing, C.E., for the works at Blackburn, for which Messrs. Wm. Bissett and Sons, Sheffield, were the contractors.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE attendance at the Cleveland iron market held at Middlesbrough on Tuesday last was better than it has been for some time past. It cannot be said, however, that there was any improvement in tone, or that prices were any firmer.

The leading makers of pig iron are still fairly well supplied with contracts, booked before prices fell so low, and they prefer to continue to put their surplus make into stock rather than sell it at present prices.

Most of the business now passing from day to day is between consumers and merchants, and makers are not in any way interested therein. By merchants 29s. 6d. per ton is now taken for No. 3 g.m.b. for prompt delivery, and in one or two cases sales of small lots have been made at as low a figure as 29s. 4½d.

Owing to the continued slackness at the finished ironworks, forge iron is in poor demand, and the price has fallen to 28s. 6d. per ton. In the present uncertainty as regards the future, neither buyers nor sellers show any inclination to do business for forward delivery.

There are no transactions to report in warrants, even though the price current has fallen to 29s. 9d. per ton.

Messrs. Connal and Co.'s accumulation of Cleveland pig iron in their Middlesbrough store had on Monday last reached a total of 231,405 tons, being an increase during the previous week of 5633 tons. At Glasgow they now hold in stock 755,720 tons.

Shipments of pig iron from the Tees have slightly improved, 36,792 tons having been exported this month, as compared with 31,550 tons in the corresponding portion of April.

There is nothing new to be said with respect to the finished iron trade. Orders are exceedingly difficult to obtain, even though makers are willing to make slight reductions on the prices recently quoted.

The last meeting for the session of the Cleveland Institution of Engineers was held at Middlesbrough on the evening of Monday, the 17th inst. Mr. Edwin Jones occupied the chair, in the absence of Mr. A. C. Hill, the president, who is still suffering from the injuries he recently received under circumstances already reported. A letter from him was read to the meeting, wherein he says that he is progressing favourably towards recovery. An interesting paper was read from Mr. R. H. Graham, of Greenwich, on "Material Economy in House Girders and Permanent Way." Mr. Graham illustrated his paper by a number of diagrams showing the most economical sections which can be used so as to give maximum strength and stability for a given cost. An interesting discussion ensued, and a vote of thanks was heartily accorded to the reader of the paper. Mr. Graham is the author of a valuable treatise on a graphic method of determining the strains on the various parts of bridges, girders, and roof principals.

The Consett Iron Company is about to extend its operations very largely in the direction of completing its arrangements for manufacturing steel plates and angles.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

BUSINESS continues very quiet in the Scotch pig iron trade. There is, indeed, some improvement in the foreign inquiry, but not such as to make itself felt with material effect in the market. The past week's shipments of pigs have amounted to 7993 tons, as compared with 9735 in the preceding week and 9223 in the corresponding week of 1886. There has been rather more inquiry for Italy, and fair quantities of iron are being sent to Canada and the United States; but the continental demand continues restricted, with prospects the reverse of encouraging. Two furnaces have been put out of blast at Messrs. Merry and Cuninghame's Arden Ironworks, and two at the Chapel Hall Ironworks of the Monkland Iron Company, and there is now a total of ninety in operation, against ninety-two twelve months ago. The putting out of these furnaces will, of course, afford some relief; but they will not nearly suffice to bring down the amount of the production to the level of current necessities, and a very considerable quantity of pigs will still go into store. The addition to Messrs. Connal and Co.'s stocks in the past week has been upwards of 6000 tons, and the stock is likely to be swelled in succeeding weeks by a large quantity of makers' iron now represented by scrip, on account of doubts being quite recently thrown on the nature of the security afforded by such paper as long as the iron remains in the possession of makers. These doubts have arisen in connection with certain financial arrangements connected with one of the iron-producing companies, and it has been necessary to call meetings of the holders of the scrip to see what arrangements could be made.

Business was done in the warrant market on Friday at 38s. 3d. to 38s. 3½d. cash. The tone was firmer on Monday, with transactions up to 38s. 7d. cash, but on the succeeding day the price fell to 38s. 4d., closing with sellers at 38s. 5d. cash. On Wednesday business took place at 38s. 5d. to 38s. 6½d. cash. To-day—Thursday—was held as a holiday in honour of the Queen's birthday, and there was no market.

The Steel Company of Scotland have obtained an order for 2000 tons of American bridgework.

The current prices of makers' pigs are as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 42s. 6d.; No. 3, 40s. 6d.; Coltness, 47s. and 42s. 6d.; Langloan, 44s. and 41s. 6d.; Summerlee, 45s. 6d. and 41s. 6d.; Calder, 46s. 6d. and 41s.; Carnbroe, 42s. and 39s. 6d.; Clyde, 42s. 6d. and 39s. 6d.; Monkland, 39s. 3d. and 36s.; Quarter, 38s. 6d. and 35s. 6d.; Govan, at Broomielaw, 39s. 3d. and 36s.; Shotts, at Leith, 44s. 6d. and 44s.; Carron, at Grangemouth, 47s. 6d. and 44s. 6d.; Kinneil, at Bo'ness, 43s. and 42s.; Glengarnock, at Ardrossan, 42s. 6d and 39s. 6d.; Eglinton, 38s. 9d. and 35s. 6d.; Dalmellington, 40s. 6d. and 37s. 6d.

In the past week there was despatched from Glasgow £2200 worth of machinery, £5586 sewing machines, £5000 steel goods, and £28,200 worth of general iron manufactures, of which £11,820 represented pipes, sheets, tubes, &c., for Sydney. There is considerable activity at the works, which are implementing foreign orders, the bulk of which at present are for India and the Australian colonies.

Certain firms of coalmasters report that they are well employed with orders for shipment, while others continue slack. The week's shipments are not quite so satisfactory as those of the preceding week. From Glasgow 30,617 tons were despatched; Greenock, 106 tons; Ayr, 8408 tons; Irvine, 1889 tons; Troon, 6595 tons; Port Glasgow, 1400 tons; Bo'ness, 7657 tons; and Grangemouth, 11,551 tons. There is no improvement in prices. The inland inquiry is quiet, the demand for household coals being on the decrease.

One of the oldest shipbuilding yards on the Clyde has just been closed. Some time ago the owners gave up business, and as they were at the time engaged on certain work for the Allan Line Steamship Company, the premises were kept open by that company until the work was completed. This being done and there being no offer for the yard, the plant has just been disposed of, and the yard closed. The purchasers of the plant are Messrs. P. and W. M'Lellan, iron merchants, Glasgow.

Messrs. A. and J. Inglis, of Pointhouse Shipyard, Glasgow, are reported to have booked a contract for two steamers of about 800 tons each for service in the English Channel. At Dumbarton, Messrs. A. M'Millan and Son have contracted to build two steel sailing vessels, one over 2000 and the other about 1200 tons, for English owners.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

MR. WALES, chief inspector of mines for South Wales, died this week at Swansea. He had held for about twenty years his position, and had passed through one of the most, if not the most, important epochs in the history of the trade. The occurrence of explosions such as those of Cymmer and Ferndale, the advent of careful legislative enactment, and of increased scientific appliances, the growth of greater consideration for the welfare of the collier, and the better feeling between employed and employer, all have occurred in his time. In the Bruce enactments he took an active part, and was chiefly responsible for the interdict against shot firing which aroused the antagonism of the colliers and coalowners. He had not the brilliancy of Lionel Brough, and may be regarded as more plodding, and more of the old school method than suits the keen investigatory spirits of our time, who seek in coal dust and other theories to solve grave problems of importance; yet in duty fearless as the humblest collier, and from the havoc of Ferndale to that of Mardy his experience was a terrible one. Mr. Wales was originally colliery manager at Dowlais, but, like a host of able men, came from the northern school.

I am glad to note the grant of medals for heroism at Mardy, but am a little surprised that some names were omitted. Mr. H. Kirkhouse certainly deserved a place amongst the gallant band. The conferring of medals for valour in mining life is a commendable thing. It has been often the subject of note in this column, and I may, without egotism, claim to have been an early advocate for its adoption.

The coal trade is again rather quiet at Cardiff and Newport, but is a little more active at Swansea. A few of the Rhondda collieries have been idle, some of the Ocean in particular, and in many a half or two-thirds of a week's work seems to have been the average. At Plymouth collieries work is slackening, but it is better at Cyfarthfa and Dowlais. At Plymouth a new fan has been erected, at the cost of £1000, which will speedily recoup itself. Plymouth collieries have been wonderfully fortunate this year with their shipping and home trade. It is a marvel to many an old inhabitant how a coal-field worked in 1801 should still be so productive, but its duration will probably be fifty years again. Such is scientific opinion, and if so, the duration of the Welsh coal-field may fairly be extended to what it has been assumed. In the "History of the Welsh Coal Trade," now being compiled, interesting facts have been gleaned of all the early workings, and the wonderful progress shown from the small level, and a half-dozen men who worked by the light of a candle, and dusted out the gas with their jackets when it became dangerous, to Abercarne with its atmosphere heated, gaseous, and thronged with 300 men stripped to the waist, and working for dear life. Abercarne, with its explosion, costing 258 lives, is a dark spot in the history.

The total coal exports from Cardiff last week were only slightly in excess of 134,000 tons, and the falling off also in this week has naturally told on railway receipts. Taff shares are quoted as low as 222, and if Rhymney shares indicate a little improvement it is chiefly in consequence of business abstracted from the Taff. The Taff, however, shows in directorial spirit no decay; in bridge work and branches it is as busy as ever. This week I saw good work being done on the Roath branch.

The steelworks are going along about the same as usual, a kind of hand-to-mouth trade prevailing. The Dowlais notice ends with this month, and it means a reduction. If the reduction will not be accepted then it means stoppage in all, or part, as circumstances may suggest. The drop in steel bar and steel rail is such as to necessitate a reduction, even though, as in the present case, the wages paid are as low as ever they have been. It is generally understood that the reduction will be accepted, and the hope is expressed that the mills will become busier. At present hundreds of men are idle, and many of the old Cyfarthfa and Dowlais ironworkers are literally begging bread.

The sales of foreign ore have been slow of late.

Copper promises to come into vogue by its freedom from oxidisation, and I see at Swansea that attention is being directed to this; and probably this branch of home industry may be better developed.

The tin-plate trade continues busiest of our trades, and though prices remain unprogressive there is a good deal being done. In the Newport district a winding-up order has been issued for Machen, and out of the assets an order very mercifully has been issued to pay £1200 due to the workpeople. In the Swansea district the exports last week figured amongst the highest on record. Seven thousand boxes were shipped in excess of make; so prices may be expected to get out of the rut they are in. Wasters are bought as low as 12s., and best brands I.C. fetch only 13s. 6d. A good order for 160,000 date boxes has been booked by a local firm.

Swansea is likely to get up an exhibition of its metallurgical industries. Its steel, for example, that shall be rolled as thin as gold leaf, and be of the durable strength fitted for the Tay Bridge; its tin-plate, which the Japanese covet, and the New Zealanders fill with choicest fruit; its lead, zinc, and spelter. The suggestion is a good one.

An instance of quick loading has just occurred at the Bute Docks, the Benhope taking on board over 1800 tons Dowlais coal in twenty-five hours.

Amongst the large cargoes of the week have been 2003 tons to Singapore, 1850 to Savona, 2100 tons to Bombay, and 1000 to Genoa.

Speculation is active as regards the successor to Mr. Wales, and Mr. Galloway is named. Had he remained as the assistant-inspector all would have been right. Now probably it will be Mr. Caduran or Mr. Randall.

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending May 15th, 1886:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 7503; mercantile marine, Indian section, and other collections, 3173. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 6 p.m., Museum, 1520; mercantile marine, Indian section, and other collections, 191. Total, 12,387. Average of corresponding week in former years, 15,344. Total from the opening of the Museum, 24,820,893.

NEW COMPANIES.

THE following companies have just been registered:—

Shelton Iron and Steel Company, Limited.

Upon terms of an agreement of the 7th inst. this company proposes to take over the business of ironmasters and iron manufacturers or converters, carried on by the co-partnership known as the Shelton Bar Iron Company at Shelton, Stoke-upon-Trent. It was registered on the 10th inst. with a capital of £250,000, in 250 shares of £1000 each. The capital of the co-partnership on the 31st of December last was £120,000 sterling, divided into 30 shares of £4000 each. The company will issue as a consideration to the co-partners, shares considered as paid up to the extent of 75 per cent. The following list contains the names of the co-partners, together with their interest in the co-partnership and the company, and also the names of non-partners, the latter of whom agree to take the number of shares in the company set opposite their names, and to pay in respect thereof £250 per share on allotment, £250 on the 2nd October, and £250 on the 2nd March, 1887:—

	Number of shares in the co-partnership.	Number of shares in the company.
*The Right Hon. Earl Granville	14½	77
*The Hon. E. F. Leveson-Gower, 14, South Audley-street	4⅕	22
*Rev. R. Lowndes, Sturminster, Newton, Dorset; S. Lowndes, 84, Oxford-terrace; Henry Lowndes, 7, Finch-lane	6	32
*T. E. Horton, Shifnal, Shropshire, ironmaster	3	16
*Stuart Rendel, M.P., 4, Whitehall-gardens	1½	8
*G. G. Leveson-Gower, M.P., 14, South Audley-street	⅘	5
*The Right Hon. Baron Wolverton	—	20
The Most Noble the Marquess of Lansdowne	—	8
*The Right Hon. Earl Spencer	—	8
*F. W. Llewellyn, Stoke-on-Trent	—	4
	30	200

The number of directors will from time to time be determined by the company in general meeting; qualification, four shares; the first are the members in the above list whose names are preceded by an asterisk; the company in general meeting will determine remuneration.

Siddeley and Co., Limited.

This company proposes to purchase the business, property, and liabilities of Messrs. Joshua and John Siddeley, of Upper William-street, Liverpool. The nature of the business to be acquired is not stated in the registered documents, and no information is afforded as to the special arrangements made with the vendors and promoters as consideration for the purchase. Power is taken to acquire and work English letters patent, granted for improvements in apparatus or machinery for refrigerating or cooling purposes. The company was incorporated on the 6th inst. with a capital of £100,000, in £5 shares, with the following as first subscribers:—

	Shares.
E. J. Toy, Athole House, Tynemouth-road, Tottenham, insurance agent	1
H. A. Kidd, 15, St Mary-square, W., shorthand writer	1
W. Foggo, jun., Roxburgh, South Norwood Park, accountant	1
H. C. Bentley, 4, Almington-street, N., insurance agent	1
J. C. Masters, 12, Hamburg-street, London-fields, accountant	1
J. C. Bates, Nuttall-terrace, Buxton, shorthand writer	1
W. R. Edwards, 42, Halsey-street, Chelsea, commission agent	1

Most of the regulations of table A apply to the company; directors' remuneration, £500 per annum, with an additional £100 for each £1 per cent. dividend over £6 per cent. per annum.

Woodhouse and Rawson Electric Contract and Maintenance Company, Limited.

This company was registered on the 6th inst. with a capital of £50,000, in £10 shares, to purchase the goodwill of the contract department of Messrs. Woodhouse and Rawson, of 11, Queen Victoria-street, and also of the electric installation, contract, and maintenance business of the Crossley Telephone Company, Limited, so far as the same respectively relate to Lancashire, Yorkshire, and Cheshire. The subscribers are:—

	Shares.
*F. L. Rawson, 11, Queen Victoria-street, electrical engineer	1
J. H. Ward, 11, Queen Victoria street, managing clerk	1
W. L. Madgen, 11, Queen Victoria-street, electrical engineer	1
*J. F. Harrison, Rawdon Hall, near Leeds, wool comber	1
*C. H. Priestley, Thorngath, Idle, near Bradford, stuff manufacturer	1
A. W. Lassen, Bradford, merchant	1
J. Renwick, 58, Olinda-road, Stamford-hill, clerk	1

The number of directors is not to be less than three nor more than six; qualification, 25 shares; the first are the subscribers denoted by an asterisk and Mr. Otway Edward Woodhouse; remuneration, £200 per annum.

Railway Construction Company, Limited.

This company proposes to construct and work railways, telegraphs, and other public works. It was registered on the 6th inst. with a capital of £220,000, divided into 20,000 ordinary shares of £10 each, and 2000 founders' shares of £10 each. The subscribers are:—

	Shares.
G. E. Way, 10, Iverson-road, Kilburn, merchant	1
C. A. Lovegrove, C. E., 11, St. John's Villas, East Dulwich	1
A. Tyson, C.E., 21, Delahay-street, Westminster	1
W. Chaplin, 69, Trinity-street, S.E.	1
A. Stannard, C.E., 5, The Cedars, Putney	1
A. G. Steward, C.E., 101, Leadenhall-street	1
W. Alfred Dawson, C.E., 21, Delahay-street	1

The number of directors is not to be less than five nor more than eight, two of whom are to be elected by the holders of the founders' shares; qualification, 10 shares; the subscribers are to appoint the first; the company in general meeting will determine remuneration.

Alfred Slatter and Co., Limited.

This is the conversion to a company of the business of electrical engineer, carried on by Mr. Alfred Slatter, trading as Alfred Slatter and Company, at Leadenhall-chambers. It was registered on the 11th inst. with a capital of £10,000, in £5 shares. The subscribers are:—

	Shares.
Edward Quick, C.E., Telford-avenue, Streatham-hill	1
Charles Major, 14, Prah-road, Finsbury Park	1
E. Felton, The Crescent, Beckenham	1
W. Wild, Leadenhall-chambers, St. Mary Axe, solicitor	1
A. L. Craig, 16, Woodvale, Forest-hill, merchant	1
J. S. Sledge, 6, Mervan-road, electrical engineer	1
F. W. Lewis, Metropolitan-chambers, New Broad-street, coal merchant	1

In lieu of a board of directors, Mr. Alfred Slatter will act as manager until he may resign or be removed by special resolution of the company. The salary of the manager will be £250 per annum.

Brilliant Incandescent Lamp Company, Limited.

This company proposes to purchase the process of G. Zanni for the manufacture of filament forming part of incandescent or other lamps. It was registered on the 8th inst. with a capital of £5000, in £1 shares. The subscribers are:—

	Shares.
*G. Zanni, 65, Gibson-square, N., electrical engineer	1
*R. Matthews, 21, City-road, surveyor	1
*S. Baugh, 11, Canonbury Park North	1
D. Zanni, 59, Cloudesley-road, N., electrician	1
S. Tugman, 98, Junction-road, N., merchant	1
J. Lea, 75, Arlington-road, Camden Town, electrical engineer	1
S. Matthews, 21, City-road, clerk	1

The subscribers denoted by an asterisk are the first directors; qualification for subsequent directors, 50 shares; the company in general meeting will determine remuneration.

British and Colonial Dermatine Company, Limited.

Upon terms of an agreement of the 7th inst. this company proposes to acquire the assets and property of the Dermatine Syndicate, Limited, of 7, William-street, Camberwell, and to manufacture dermatine (a substitute for gutta-percha for insulating, waterproofing, &c.), and to sell all chemical and other productions of a similar character. It was incorporated on the 8th inst. with a capital of £100,000, in £5 shares. The purchase consideration is the very substantial sum of £40,000 in cash, or at the discretion of the directors, one moiety in cash and the other fully-paid shares. Mr. Maximilian Zingler, the inventor, is appointed chemical and technical superintendent for five years at a salary of £400 per annum. The subscribers, who are responsible for £5 only, are:—

	Shares.
*Sir H. C. Mance, Manora Lodge, Bedford	1
M. Zingler, 16, Fenchurch-street, secretary of a railway company	1
*W. W. Lander, 26, Throgmorton-street, secretary Imperial Ottoman Bank	1
W. C. Watson, 7, Great Winchester-street, merchant	1
*C. Kuypers, Leadenhall House, merchant	1
J. S. Waterfield, 7, William-street, Camberwell, manager Dermatine Syndicate	1
J. J. Michael, 23, St. Quintin-avenue, North Kensington	1

The number of directors is not to be less than three nor more than seven; qualification, 50 shares; the first are the subscribers denoted by an asterisk and Mr. G. H. M. Batten, of Rawlstone-street; remuneration, £100 per annum to each director; also £20 per cent. of surplus profits after payment of £10 per cent. per annum dividend.

Holmberg Safety Match Company, Limited.

This is the conversion to a company of the business of Mr. Eric Holmberg, of the Sodertelje Match Factory, in the town of Sodertelje, Sweden. It was registered on the 8th inst. with a capital of £50,000, in £1 shares. The subscribers are:—

	Shares.
Captain F. Pinzon, Friern-road, Dulwich	1
C. A. Sodeberg, 145, Whitechapel-road	1
R. A. Panchaud, 10, Garfield-terrace, Forest-gate, accountant	1
L. Southall, 29, Spurston-road, E., clerk	1
J. Walker, Sidcup, Kent, shorthand writer	1
T. W. Priske, 47, Newington-green-road	1
C. J. Otway, 140, St. Thomas-road, Finsbury Park	1

Most of the regulations of Table A of the Companies' Act, 1862, are adopted. Directing qualification, £100 in shares or stock.

Venezuelan Austin Gold Mining Company, Limited.

This company was registered on the 6th inst. with a capital of £850,000, divided into 20,000 8 per cent. preference shares of £10 each, and 650,000 ordinary shares of £1 each, to acquire, work, and develope the auriferous mines in Venezuela, known as Austin Numbers 1 to 10, and Corina, and woodlands and other property connected therewith. The subscribers are:—

	Ord. Shares.
S. Allgelasto, 19, Great Winchester-street, bank manager	1
C. F. Pearson, 3, Draper's-gardens, stockbroker	1
G. H. Bowyer, 27, Old Broad-street, bullion broker	1
S. A. Pixley, 27, Old Broad-street, bullion broker	1
H. Herbert, 81, Old Broad-street, stockbroker	1
E. Fayersy, 19, Great Winchester-street, bank accountant	1
A. J. Shepherd, 39, Vartry-road, Stamford-hill	1

The number of directors is not to be less than five nor more than eight; qualification, £4000 of nominal, £1000 of which must be in preferred shares; the subscribers are to appoint the first; remuneration, £2000 per annum, and in addition 10 per cent. of the surplus profits remaining after payment of 8 per cent. dividend. The purchase consideration is £72,000 in respect of the concession of the mines, payable £12,000 cash, £30,000 in ordinary, and £30,000 in preference shares; also the allotment to the liquidator of the Nacupai Gold Mining Company, Limited, of £52,000 in preference and £185,000 in deferred shares, all such shares to be considered as fully-paid. The company further undertakes to pay £80,000 in cash for a lease of the woodlands for a term of 99 years, when the same become payable under the existing arrangements of the Nacupai Gold Mining Company, Limited.

Joshua Stubbs, Limited.

This is the conversion to a company of the business of metal manufacturer, carried on by Mr. Joshua Stubbs, at the Brunel Works, Pilney-street, Aston, Warwick. It was registered on the 11th inst. with a capital of £20,000, in £10 shares. The subscribers are:—

	Shares.
A. Turner, Birmingham, engineer's foreman	1
Mrs. E. Stubbs, Birmingham	4
John Stubbs, Birmingham, metal dealer's manager	1
Miss R. E. Stubbs, Birmingham	3
*W. Abbott, Birchfield, Stafford	1
*Joshua Stubbs, Birchfield, metal manufacturer	1
J. Evans, Birchfield, leather worker	1

The subscribers denoted by an asterisk are the first directors; qualification, five shares. Mr. William Abbott is appointed chairman at a salary of £100 per annum.

New Oscar Gold Company, Limited.

This company proposes to acquire from the Oscar Gold Mining Company, Limited, mineral properties situate in the Island of Bonnell, Norway. It was registered on the 8th inst. with a capital of £100,000, in £1 shares; 36,0ι0 shares are to be allotted as fully-paid up, and 64,000 may be allotted as paid up to the extent of 15ı. per share. Power is taken to issue £15,000 of mortgage debentures, secured as a first charge upon the property and assets of the company, including uncalled capital. The subscribers are:—

	Shares.
J. H. A. Smith, Austinfriars, secretary to a company	1
J. Hutchings, Hillingdom, Middlesex	1
G. W. Ritchie, Larkhall-rise, Clapham, clerk	1
H. C. Stewart, 13, Great Winchester-street, accountant	1
G. H. Allen, 42, Sparsholt-road, Crouch-hill, accountant	1
C. H. Smith, 8, Austinfriars, secretary to a company	1
E. G. Fisher, 6, Lulworth-road, Peckham	1

The number of directors is not to be less than two nor more than seven; qualification, 300 shares; the first are Major Robert Heane, and Messrs. Henry Bentley, John Daw, and Francis Vaughan Williams; remuneration, £100 per annum to each director.

EXPERIMENTAL WORKS FOR IMPROVING THE FAIRWAY OF THE RIVER DON.*

By L. LUBIMOFF.

THE author, after discussing the features of the Don generally, and pointing out the causes which contribute to the formation of sandbanks and other obstructions, proceeds to give a short history of the attempts made since 1876 to improve the navigable channel. He describes two or three forms of removable wooden groynes which were tried, but with indifferent success, on account of the time required for their construction and the necessity of removing them early in the autumn, and points out that permanent groynes made of stone, of which there is abundance along the course of the river, cannot be adopted in the first instance because of the uncertainty of the effect of a given line of groyne on the current, and the danger of the loose stones being carried into the fairway. Under such circumstances it was determined to try groynes built up of sand-bags. In the year 1879, and again in 1882, the agent of the Volga-Don Navigation Company had rapidly and successfully improved the channel in two places by the proposed method, but it was not till 1883 that serious attempts were commenced for a scientific application of sand-bag groynes by the engineers in charge of the river.

The author proceeds to describe in detail the method of filling the grain-bags, made of bass-mats, and depositing them in the bed of the river. The sections of the groynes form triangles with bases of from one to four sacks wide, laid lengthways, and from one to four sacks high, according to the depth of water and the strength of the current. As many as 7500 bags had been laid in a single groyne. Fifty sacks measured 343 cubic feet, and cost, deposited in place, £2 6s.

The paper is illustrated by plans of three shallows which had been successfully dealt with, and by plates giving in detail the construction of the temporary wooden groynes which were first used.

ENGINEERING SOCIETY, KING'S COLLEGE, LONDON.—At a general meeting held on Tuesday, 11th inst., Mr. W. H. Collis read his presidential address on "Curves." These he discussed not mathematically, but in their practical applications, dwelling particularly on several of the best known examples. The steam engine diagram was the first mentioned, and was followed by a short statement of the method of constructing inertia diagrams. An explanation was then given of how to calculate temperatures from gas engine diagrams. The author then passed on to describe the characteristic curves of dynamos. He also showed how to deduce a characteristic for a machine running at a different speed, or when wound with more or less turns of wire. The graphical method of discovering the most economical number of volts to run an incandescent lamp at formed another example, illustrated by an actual case worked out. Curves obtained in testing the behaviour of metals when stressed were alluded to at some length, and diagrams taken from a Thurston machine were kindly lent by Professor Huntington. A brief description of the autographic recording apparatus of Wicksteed and Kennedy closed the paper.

* "Proceedings" Inst. Civ. Eng. Abstract from *Ingener*, St. Petersburg.

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.

11th May, 1886.

6310. FILTERING, C. C. Gilman, London.
6311. WRENCH, M. Potter and W. V. Gulick, London.
6312. WINDOWS, J. Mason, West Hartlepool.
6313. DIPPING SHEEP by HAND, J. A. Wood, Weston-super-Mare.
6314. GLOVES, G. W. and E. Wilson, Manchester.
6315. STRAP FASTENERS, W. R. Harris, Manchester.
6316. BINOCULAR CAMERA, J. Hancock, jun., Newcastle-on-Tyne.
6317. ORNAMENTAL FRINGING, W. Fairweather, Manchester.
6318. WASHING and DRYING SUN COPIES of DRAWINGS, B. D. Healey, Liverpool.
6319. CORKSCREWS, G. J. Harcourt and E. Shaw, Bristol.
6320. PARCEL CARRIER, W. H. Smith, Birmingham.
6321. METALLIC CLIP, G. Slater, Sheffield.
6322. SEWING MACHINES, J. H. Johnson.—(*E. Recordon and Co., France.*)
6323. MUSIC STOOLS, J. Simpson, Glasgow.
6324. FOLDING BLINDS for WINDOWS, A. J. Arthur, London.
6325. TOY FIRE-ENGINES, G. Chamboredon and A. Merlin, London.
6326. PREVENTING SLIPPING on SURFACES, J. Duffy, London.
6327. TEAPOTS, J. J. Royle, London.
6328. HORSESHOES, J. W. Smith and F. W. Green, sen., Birmingham.
6329. PORTABLE ADVERTISING MEDIUM, F. Bosshardt.—(*V. Chauvet, France.*)
6330. PERAMBULATORS, &c., J. Stables and W. Selley, London.
6331. DISINFECTING and FUMIGATING MACHINE, A. Y. Germains, London.
63ı2. HYGIENIC BISCUITS for HORSES, E. J. T. Digby, London.
6333. MACHINE for CLEANING BOOTS, F. E. Evrington Fulham.
6334. MINERS' SAFETY LAMPS, J. Douglas, London.
6335. FILING LETTERS, B. J. Rubinstein, London.
6336. SCREW DRIVING, W. Chambers, London.
6337. SPIRIT LEVELS, W. W. Hulse, London.
6338. RAILROAD TRACK CROSSINGS, F. J. Hoyt, London.
6339. PUNCHING METALLIC PLATES, R. A. Hardcastle, London.
6340. FUSES for EXPLOSIVE SHELLS, E. L. Zalinski, London.
6341. MOTORS, E. B. Benham, Liverpool.
6342. REDUCING the SUDDEN STRAIN on ROPES for HOISTS, A. Smith, London.
6343. STRETCHING TROUSERS, T. Stonehewer, jun., London.
6344. GULLIES and TRAPS, J. Kudlicz and J. Václavek, London.
6345. LOCALISING FAULTS in SUBMARINE TELEGRAPH CABLES, J. Gott and H. Kingsford, London.
6346. MINERAL OIL LAMPS, H. Fricker.—(*R. M. Wanzer, Canada.*)
6347. CONVERSION into GAS of LIQUID HYDROCARBONS, O. Imray.—(*J. B. Archer, United States.*)
6348. BOILER FURNACES for COMBUSTION of GASEOUS FUEL, O. Imray.—(*J. B. Archer, United States.*)
6349. MANUFACTURING WATER OIL GAS, O. Imray.—(*J. B. Archer, United States.*)
6350. STREAM TURBINE, W. Nossian and H. Hut London.
6351. GAS LAMPS, J. H. Sheldrake, London.
6352. SECURING LOCK and DOOR HANDLES or KNOBS to their SPINDLES, J. Wilson, Glasgow.
6353. SHIPS' COMPASSES, C. F. F. Wilke, London.
6354. CENTRE BOARDS for VESSELS, J. A. Deering, London.
6355. VELOCIPEDES, A. Burdess, London.
6356. BALL BEARINGS, M. D. Rucker and R. F. Phillips, London.
6357. REGULATING CHARGING and DISTRIBUTING CIRCUITS where SECONDARY BATTERIES are used, Sir D. L. Salomons, Bart., London.
6358. SUSPENDED LAMP, Sir D. L. Salomons, Bart., London.
6359. SUPPORTING DEVICE for CARDS, &c., J. C. Fell.—(*W. Hagelberg, Germany.*)
6360. BURGLAR ALARMS, H. J. Haddan.—(*The National Manufacturing Company, United States.*)
6361. WRENCHES, A. P. Quigley, London.
6362. PROMOTING the COMBUSTION of FUEL, H. J. Haddan.—(*H. Welsh, United States.*)
6 .63. VELOCIPEDES, T. J. de Sabla, London.
6364. LOWERING MECHANISM for DENTISTS' CHAIRS, L. Stuck, London.
6365. PREVENTING NOISE in CLOSING DOORS, G. B. Thornton, London.
6366. SIMULTANEOUSLY CLOSING, FASTENING, &c., the DOORS of RAILWAY CARRIAGES, H. G. Govier, London.
6367. METALLIC ALLOYS, P. A. Newton.—(*C. A. Paillard, Switzerland.*)
6368. STEAM ENGINES, H. E. Newton.—(*C. C. Worthington, U.S.*)
6369. MEASURING ELECTRICITY, S. Pitt.—(*J. Cauderay, France.*)
6370. OXIDE of IRON PIGMENT COLOUR, R. Lavender, London.
6371. INTERNALLY-FED CIRCULAR COMBING MACHINES, J. W. Bradley, Bradford.
6372. ROLLING and WELDING of IRON and STEEL, H. H. Lake.—(*E. E. Wood, U.S.*)
6373. BLINDS, SCREENS, or CURTAINS, I. Kezapcioglou, London.
6374. MACHINE BELT, W. L. Teter, London.
6375. PRINTING and REGISTERING MECHANISM, C. Busch, London.
6376. HEATING STOVES, H. Heim, London.
6377. PIANO and other STOOLS, H. H. Lake.—(*A. C. Haynes, U.S.*)

12th May, 1886.

6378. VALVE GEAR for STEAM ENGINES, &c., R. Rickie, Glasgow.
6379. HINGES and FASTENING DEVICES, D. Frew, Glasgow.
6380. SHUTTLE GUARD, P. H. Marriott, Manchester.
6381. CAST STEEL NEEDLE-POINTED TEETH, L. E. and G. F. Priestley, Halifax.
6382. SKIPS and BASKETS, C. Haigh, Huddersfield.
6383. PRINTING DIRECT in SWIFT-RUNNING ROTARY WEB PRINTING MACHINES with METAL ENGRAVINGS, D. C. Thompson, Dundee.
6384. KETTLE, A. Ashby, W. J. Barrett, and G. Cook, Luton.
6385. OIL LAMPS, G. Roby, Bolton.
6386. SODA, G. Chapman, Glasgow.
6387. SURFACES of TEAPOTS, &c., R. and R. T. Sturges and W. J. Vaughan, Birmingham.
6388. CLEANING POTATOES, T. G. Shaw, Manchester.
6389. MACHINE for PLANING REED RIBS, &c., J. Kershaw, Clayton.
6390. DOUP HEALDS for WEAVING GAUZE, &c., J. Kershaw, Clayton.
6391. MECHANICAL MUSICAL INSTRUMENTS, F. E. P. Ehrlich, London.
6392. PULVERISING PLOUGHS, W. Dewar, Strathmartine.
6393. FASTENINGS for RAILWAY CHAIRS, &c., A. B. Ibbotson, Sheffield.
6394. MOUNTING MAPS, PLANS, CHARTS, &c., J. W. Webster, London.
6395. STREET and other PAVEMENTS, T. M. H. Flynn, Bessbrook.
6396. DISH, M. M. R. Barrett and A. E. Scott, London.
6397. SODA-WATER, LEMONADE, &c., OPENER, R. E. Miller, London.

6398. MEASURING, &c., the FLOW of LIQUIDS, J. Strick, London.
6399. VIOLIN BRACELET, O. Langey, London.
6400. SLEEPERS for RAILWAYS, &c., B. G. Martin, London.
6401. PASTEURISING BEER, WINE, &c., H. Schaarwächter, Barmen.
6402. HOB GRATES, G. D. Innes, London.
6403. STEAM ENGINES, W. H. Wheatley, Lewisham, and J. W. McKenzie, Cheadle.
6404. COATING the SURFACE of IRON, &c., with TIN, LEAD, or TERNE, A. Gutensohn, London.
6405. COATING IRON or STEEL with LEAD, A. Gutensohn and A. Cox, London.
6406. MILK MIXING COCK, E. Pabst, London.
6407. VALVES for FLUID MOTIVE POWER ENGINES, &c., J. Spence, Glasgow.
6408. HANSOM CABS, E. E. Allen, London.
6409. REGISTERING APPARATUS for CABS, &c., E. E. Allen, London.
6410. ENVELOPE, &c , FOLD, A. E. Ames and A. Pilsworth, London.
6411. MULTIPLE CYLINDER ENGINES, E. T. Hughes.—(H. Bouron, France.)
6412. REMOVING SHELLS from the KERNELS of COCOA NUTS, J. P. West and D. Gibson, London.
6413. GALLIC ACID for DYEING, &c., J. H. Johnson.—(The Badische Aniline and Soda Fabrik, Germany.)
6414. COMPRESSED AIR for PROPELLING VEHICLES, &c., H. Bosustow, Leyton.
6415. SYRINGES, J. B. Simas, J. A. Mansfield, and J. Skilling, London.
6416. INDUCTION COILS, H. H. Lake.—(E. B. Hamlin, United States.)
6417. AIR-TIGHT COVERS or LIDS, J. Smeaton, London.
6418. STARTING DEVICE for TRAMWAYS, J. Gilmore and W. R. Clark, London.
6419. CHEQUES, J. Gilmore, London.
6420. PERMANENT WAY, A. M. Clark.—(C. F. M. T. Lartigue and O. Bertram-Bocandé, France.)
6421. NOVEL UTILISATION of WOODS, J. Hlošek, London.
6422. ARMATURES for MAGNETO, &c., GENERATORS, J. G. Statter L. and S. Brunton, London.
6423. PNEUMATIC VALVE, T. J. Baker, Birmingham.
6424. ULTRAMARINE BLOCKS, L. J. B. A. J. Bouillet, London.
6425. THRUST-BEARINGS for SCREW-PROPELLER SHAFTS, C. J. Copeland and R. Bickerdike, Manchester.
6426. CONSTRUCTING FLOORS and ROOFS, &c., W. Parry, Caelleppa.
6427. SIZING, &c., YARNS, W. G. Bywater and T. B. Beanland, Leeds.
6428. DELIVERY of PREPAID GOODS, F. C. Lynde, Manchester.
6429. WEIGHING MACHINES, F. C. Lynde, Manchester.
6430. WATER FILTERS, J. Ridge, Sheffield.
6431. EXHIBITING VIEWS in MAGIC LANTERNS, J. T. Key, Sheffield.
6432. PRINTING MACHINES, J. H. Missong, London.
6433. LATHE for POLISHING the INSIDE of ROUND and OVAL HOLLOW WARE, W. Burton, Birmingham.
6434. HAT VENTILATORS and GUARDS, F. R. Baker, Birmingham.
6435. DYEING HOSIERY, &c., H. Broadbent and A. E. Hawley, Halifax.
6436. CLEANING KNIVES, T. Jenks, Bath.
6437. DOOR LOCK SPINDLE, G. Gopsill, Handsworth.
6438. SEAL SPLITS or FLESHINGS, R. and W. Baker, London.
6439. LOOMS for WEAVING, C. Bowles and W. Cairns, Belfast.
6440. IMPARTING PERCUSSIVE, &c., MOTION to ROCK DRILLS, F. C. Phillips and H. E. Harrison, London.
6441. CENTRE BORING BITS, N. R. Rosekilly, Calstock.
6442. DRAWING-OFF MEASURED QUANTITIES of LIQUIDS, F. W. Leviorge, London.
6443. BARREL ORGANS, W. Binder, London.
6444. KEYS or WEDGES for RAILWAYS, W. Strapp, Red Hill, and G. Edwards, Thornton Heath, Surrey.
6445. LAMPS, C. H. Fitzmaurice and W. L. Cooper, London.
6446. SUSPENDERS, A. J. C. Graf, London.
6447. PRESSURE REDUCING VALVES, G. Cockburn and A. W. Baird, Glasgow.
6448. PERAMBULATORS, W. H. Dunkley, London.
6449. BURNING GAS for ILLUMINATING, &c., J. Horton, Glasgow.
6450. OSCILLATING HOOK for SEWING MACHINES, J. Vannett and G. S. Yingling, London.
6451. STIFFENERS for STAYS, &c., J. G. Ingram, London.
6452. TONGUING for WOOD or STONE, H. J. Haddan.—(A. Lamy, France.)
6453. BUCKLES, R. Kuhnert, London.
6454. CANDLE HOLDER, J. Davies, London.
6455. TOY CARRIAGES, S. Günthermann, London.
6456. WADS for SHOT GUNS, W. F. Beart, London.
6457. REEL for HOSE PIPES, J. Haynes, London.
6458. MARKING PHOTOGRAPHIC NEGATIVES, N. Browne.—(C. J. F. Kruse, Germany.)
6459. GRAIN BINDING HARVESTERS, G. F. Redfern.—(B. E. Huntley, United States.)
6460. CARRIAGES, G. F. Redfern.—(Hippolyte Laine-Plisson, France.)
6461. HORSE HOES, E. Evans, London.
6462. HANDLES or KNOBS subject to HEAT, P. M. Justice.—(G. W. Percy, United States.)
6463. MACHINES for COILING WIRE, P. M. Justice.—(G. W. Percy, United States.)
6464. RAILWAY SLEEPERS and CHAIRS, J. Howard and E. T. Bousfield, London.
6465. DEVICE for CONTAINING OLEAGINOUS SEEDS, E. P. Chauvet and E. A. Delrieu, London.
6466. TELEPHONES, H. W. B. Brighten, London.
6467. VULCANISABLE GILDING MATERIAL, J. H. Wood, London.
6468. BI-CHROMATE of POTASH, W. Simon, London.
6469. CABINET for STATIONERY, &c., C. J. Guy, London.
6470. PURE WHEATEN BREAD, E. C. C. Diels and H. Cooper, London.
6471. ELECTRIC TELEPHONY, J. G. Lorrain, London.

14th May, 1886.

6472. FASTENERS for SCARVES and NECKTIES, W. Wilkinson, London.
6473. BURGLAR and FIRE-ALARM, J. A. Swinscoe, Sheffield.
6474. OPENING and CLOSING DOORS, J. Barrett, Bradford.
6475. TIEING BRICKS or STONES TOGETHER, T. and W. Garforth, Halifax.
6476. REPAIRING OLD WATER TAPS, E. Budge, Huddersfield.
6477. SNARING SIDE DRUMS, T. Rawson, Manchester.
6478. STOPPERING BOTTLES, C. Herbert, Oldham.
6479. ATTACHING CUTTING BLADES in GUILLOTINE MACHINES, J. Hamilton, Glasgow.
6480. MINERS' SAFETY LAMPS, W. Patterson, Durham.
6481. STOPPERING BOTTLES, J. Greaves, Oldham.
6482. BENDING IRON or STEEL BARS, W. Noble, jun., Glasgow.
6483. SHUTTLES, J. Hardwick, North Bradford.
6484. GAS ENGINES, L. Mills, North Shields.
6485. RECEIVING BOX for TICKET PRINTING MACHINES, F. J. Wood, Newton-le-Willows.
6486. HOPPER VENTILATING CASEMENTS, H. F. Price, Weston-super-Mare.
6487. SWITCHES for ELECTRICAL CURRENTS, W. Hartnell, Leeds.
6488. SLIDING ASHES PAN, J. Morton and R. Searle, Sheffield.
6489. RECORDING DISTANCES, FARES, &c., J. Newey, Birmingham.
6490. PAPER FASTENER, F. H. Richards, Hartford, U.S.
6491. WINDOW BLINDS, S. E. Jackson, G. H. Herbert, and E. Hazlehurst, London.
6492. PRODUCING CARBONIC ACID under CONSTANT PRESSURE, W. H. Munns.—(P. Farinaux, France.)
6493. COMMUNICATING MOTION to REVOLVING SHAFTS and DISCONNECTING MOTORS THEREFROM, W. W. Beaumont, London.
6494. HEATING HORTICULTURAL, &c., BUILDINGS, R. Porter, London.
6495. DEPOSITION of FINELY DIVIDED MATTER FLOATING in AIR, &c., J. G. Lorrain, London.
6496. LOCK NUTS, A. J. Boult.—(T. D. Linet, Belgium.)
6497. FOOT PADS for ANIMALS, J. J. Fraser, London.
6498. BOOTS and SHOES, T. Brown, London.
6499. AUTOMATICALLY DELIVERING LIQUIDS or SOLIDS, F. Freeman, London.
6500. MILITARY EQUIPMENTS, F. H. Reynolds and W. B. Chapman, Montreal.
6501. DRINKING FLASKS, W. T. Wright and F. Davies, London.
6502. FURNACES, MUFFLES, &c., A. M. Clark.—(M. M. Bair, France.)
6503. FURNACES, &c., A. M. Clark.—(M. M. Bair, France.)
6504. CARD-SETTING MACHINES, S. Midgley, London.
6505. BRAKES for VELOCIPEDES, O. Strehle, London.
6506. BOTTLES, SYPHONS, &c., W. P. Wilson, London.
6507. ELECTRIC LIGHTING APPLIANCES, R. P. Sellon, London.
6508. ELECTRIC METERS, R. P. Sellon, London.
6509. GAS FITTINGS, P. M. Justice.—(W. J. Comley, United States.)
6510. PREVENTING the DEPOSIT of MATTERS in WATER TUBES, H. J. Worssam and H. Hunt, London.
6511. GAS, F. W. Clark, London.
6512. INDIA-RUBBER BELTING, C. H. Gray, London.
6513. HANDLES of SPADES, D. Yardley, London.
6514. MANUFACTURE of LATCH STAPLES, J. Banks, London.
6515. BARRELS, W. A. Barlow.—(H. Wessel, Germany.)
6516. MACHINES for PRESSING CLOTH, W. and S. Bash, and M. A. Prenslan, London.
6517. STOVES, A. Rust, London.
6518. LINOLEUM, J. Trotter, London.
6519. FLUSHING APPARATUS for CANALS, T. Kommerell and E. Edwards, London.

15th May, 1886.

6520. TREATMENT of SEWAGE WATER, G. R. Redgrave, London.
6521. AUTOMATIC ROCKER, S. D. McKellen, Manchester.
6522. GAUGING DOUGH, J., T., and J. Vicars, jun., Liverpool.
6523. OPERATING the PICKING TAPPET of LOOMS, A. Sowden, Halifax.
6524. LETTING-OFF MOTION for the PIPE WARP in LOOMS, H. Barton, jun., Manchester.
6525. PREVENTING STOPPAGES in the STUFF TAP of PAPER-MAKING MACHINERY, T. Rowland, Halifax.
6526. BEDS, I. Chorlton and G. L. Scott, Manchester.
6527. STEAM BOILERS, T. Fletcher, Manchester.
6528. PLOUGHS, J. Hornsby, J. Money, and W. Grice, Grantham.
6529. ROTARY ENGINES, J. A. Fielding, Abergele.
6530. GOVERNING and CONTROLLING STEAM ENGINES, J. Roberts, Cleator Moor.
6531. HEATING by GAS, W. Foulis, Glasgow.
6532. EDGE CUTTER for CUTTING TURF, J. Monteith, Glasgow.
6533. CLOSING or PREVENTING LEAKS in SHIPS at SEA, G. Watson, Glasgow.
6534. ELECTRIC ARC LAMPS, C. A. A. Capito, London.
6535. CAST METAL or EARTHENWARE JAW-BOXES, &c., J. Lockwood, Glasgow.
6536. CLOTHES HORSE, D. Lewis, Staffordshire.
6537. OILING WOOL or other FIBRE, J. Campbell, Bradford.
6538. STOPPING LEAKAGE in BOATS, &c., T. Weir, Dublin.
6539. METALLIC BEDSTEADS, &c., A. L. Bayley, Birmingham.
6540. COVER SUITABLE for STACKS, R. H. Clapham, London.
6541. CUTTING BRADS, &c., J. Moore, London.
6542. AUTOMATIC WATER VALVE for SPINNING TROUGHS, W. J. Downey, Beesbrook.
6543. BACK-FLAP STOP-HINGE for DOORS, W. C. Pollock and R. Hoyle, London.
6544. NAVIGABLE VESSELS, W. Chadburn, Liverpool.
6545. COMPOUND INGOTS, J. H. Goodwin and F. James, Sheffield.
6546. CLEANING and REPAIRING WINDOWS, D. F. Saunders, London.
6547. SUBSTITUTE for OPAL or other TINTED GLASS, W. and G. J. Turner, London.
6548. SECTIONAL WARPING and BEAMING MACHINES, J. H. Stott and J. Smith, Manchester.
6549. CORRUGATING METAL SHEETS, D. Smith, jun., London.
6550. PRODUCING METALLIC ALLOYS, T. Slater, London.
6551. COMBINING ATMOSPHERIC AIR with PETROLEUM, J. Wright, T. Charlton, and C. S. Wright, London.
6552. HATS, S. Schwarz, London.
6553. UTILISING METALLIC and other CEMENTS, T. Smith, London.
6554. PROPELLING STEAM VESSELS, R. Morris, Newcastle-on-Tyne.
6555. RECEPTACLE ATTACHMENT for DASH BOARDS, M. Fahey, London.
6556. CONTINUOUS LIFTS, H. C. Walker and R. Carey, London.
6557. COMBINATION PIPE, W. A. Holmes, London.
6558. SELF-ACTING FIRE ALARUM and EXTINGUISHER, E. P. Blackmur, London.
6559. WARDROBES and PORTABLE CUPBOARDS, W. H. and G. Barker, London.
6560. HAIR PINS, &c., G. A., A. S., and H. J. Spratt, London.
6561. TRICYCLES, W. Smith and G. Hicking, London.
6562. PATTERNS for WATERPROOF CLOTH, H. J. Haddan.—(M. Rothenbücher, Germany.)
6563. TRANSMITTING SIGNALS, A. M. Chambers and W. Durant, London.
6564. PIANOFORTES, J. J. Rayment, London.
6565. CLOSING DOORS, J. H. Bean and W. Gaines, London.
6566. HARVESTERS, W. M. Cranston.—(The Walter A. Wood Mowing and Reaping Machine Company, United States.)
6567. DUST COLLECTORS for FLOUR MILLS, J. G. Lorrain, London.
6568. WOOD SCREWS, G. G. M. Hardingham.—(J. C. Lathailliere, France.)
6569. EXTINGUISHING FIRES, W. R. Lilly, London.
6570. MANURE DISTRIBUTORS, H. Reeves, London.
6571. STEEL in BESSEMER CONVERTERS, &c., W. D. Houghton and A. M. Walker, London.
6572. STEEL in BESSEMER CONVERTERS, &c., W. D. Houghton and A. M. Walker, London.
6573. ALUMINA COMPOUNDS for BLEACHING, R. Weiss, London.
6574. ELECTRIC BURGLAR, &c., APPARATUS, S. Taussig, London.
6575. PERMANENT WAY of RAILWAYS, T. W. Smith, London.
6576. PILOT BOATS, &c., J. C. Robertson, London.

17th May, 1886.

6577. IRONING MACHINES, J. B. Alliott and E. L. Caron, Manchester.
6578. SUPPORTS for STAYS, &c., E. J. Jones, Kingston-on-Thames.
6579. CONTROLLING BALL, &c., TAPS, S. H. Wright, Carnforth.
6580. FLUSHING CISTERNS for WATER-CLOSETS, &c., S. H. Wright, Carnforth.
6581. TRAPPING the DISCHARGE PIPES of CISTERNS, &c., S. H. Wright, Carnforth.
6582. EXHAUSTING SYPHONS, S. H. Wright, Carnforth.
6583. ROTARY WEB PRINTING MACHINES, T. G. Dawson, Bradford.
6584. FOLDING APPARATUS for ROTARY WEB PRINTING MACHINES, T. G. Dawson, Bradford.
6585. REGULATING PULP to PAPER-MAKING MACHINES, J. G. Dunbar and A. McKenzie, Glasgow.
6586. LIGHTING TRAINS by ELECTRICITY, T. P. Carswell, Glasgow.
6587. SOLITAIRES and STUDS, C. Wingfield, Sheffield.
6588. MIXING CHLOROFORM with WATER, C. E. Landon and J. Wilson, Birmingham.
6589. METALLIC BEDSTEADS, R. G. V. van Avezathe, Wolverhampton.
6590. FRAMES for holding PICTURES, R. Mander, Birmingham.
6591. EAR-RINGS, M. H. Tilley, Dorchester.
6592. PATTERN MECHANISM of LOOMS, F. W. Jepson, Halifax.
6593. UNIONS for HOSE, T. G. Normanton, Barrow-in-Furness.
6594. STEAM-ENGINES, N. Chandler, Hednesford.
6595. SHADING PLUSH FABRICS, T. Salt, London.
6596. DOUBLE SOLENOID for ELECTRIC INDICATORS, C. W. Cox, Liverpool.
6597. GAS OVENS, T. Redmayne, Sheffield.
6598. ELECTRICAL SWITCHES, R. H. C. Nevile, Grantham.
6599. FIXING, &c., ELECTRICAL INSULATORS, J. E. Griffith, Upper Bangor.
6600. SHIELD for KEEPING WATER out of VESSELS, D. A. Stanley, London.
6601. MATCH STANDS, J. J. Beaumont, Sheffield.
6602. ARTIFICIAL BAITS, F. C. Leader, London.
6603. LIGHTING and EXTINGUISHING GAS LAMPS, J. J. Butcher, Newcastle-on-Tyne.
6604. GALVANIC CELL for BELL RINGING, G. H. Bays, jun., Wakefield.
6605. VENTILATING WATERPROOF GARMENTS, C. Rogers, Ardwick.
6606. BACK REST and SEAT for VEHICLES, H. S. M. Bath, Hanley.
6607. FASTENING BLADES of COULTERS to their STEMS, F. Buchan, London.
6608. SELF-ACTING VENT PEGS, E. W. Hughes and G. V. Jameson, London.
6609. FURNACES for MELTING METALS, E. Fox and L. Regnier, London.
6610. MACHINES for SAWING STONES, &c., J. Peckover, London.
6611. TRICYCLE, G. Willcock and W. Willcock, Plumstead.
6612. GAS-MOTOR ENGINES, J. Gillespie, London.
6613. BOTTLING AERATED LIQUIDS, F. White, London.
6614. APPLYING FORCED DRAUGHT to BOILERS, G. W. Manuel, London.
6615. PNEUMATIC HAMMERS, A. Taylor, London.
6616. CONVERTERS, E. Servais, London.
6617. VICES, J. Kenyon, J. Barnes, and R. W. Kenyon, Liverpool.
6618. HOLDING and PUTTING OFF SHIPS' BOATS, W. J. Gell, Liverpool.
6619. ELECTRIC TYPE PRINTING INSTRUMENTS, O. Romanze, London.
6620. CANDLES, H. J. Haddan.—(L. von Wohlfahrt, S. Heumann, and E. Heimann, Austria.)
6621. INDICATORS for ELECTRIC BELLS, C. W. Stewart, Penge.
6622. BOTTLES for PREVENTING FRAUD, W. L. Wise.—(L. Meynieu, France.)
6623. PERAMBULATORS, &c., D. J. Greig, London.
6624. ENGINE, &c., PISTONS, L. Grabau, London.
6625. PEDO-CYCLE, W. Stobbs and W. Bullard, London.
6626. HOPPER LIGHT REGULATOR and FASTENER, E. and J. M. Verity, and B. Banks, Leeds.
6627. LOOMS for WEAVING, S. C. Lister and F. H. Wilke, Bradford.
6628. FILTER PRESSES for USE under HIGH-PRESSURES, H. E. Newton.—(A. L. G. Dehne, Germany.)
6629. WATER-GAUGE for STEAM BOILERS, D. Pyke, London.
6630. BOTTLE STOPPERS, J. C. Schultz, London.
6631. PREPARING PRINTING COLOURS for PRINTING on COTTON, &c., J. H. Johnson.—(The Badische Anilin and Soda Fabrik, Germany.)

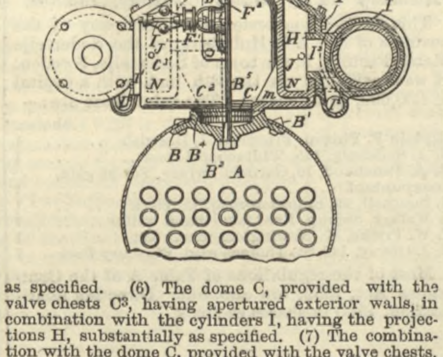
SELECTED AMERICAN PATENTS.

From the United States' Patent Office official Gazette.)

337,840. TRACTION AND OTHER ENGINES, *Frank F. Landis, Waynesborough, Pa.—Filed November 28th, 1885.*

Claim.—(1) The combination with a steam boiler of an annular casting having a concave bearing and a steam dome having a companion convex bearing on the bottom thereof mounted and secured upon said casting substantially as specified. (2) The combination of the boiler A, spider casting B, having the concave bearing B^4, dome C, having the flange C^1 and convex bearing C^2, and a bolt or bolts, substantially as specified. (3) The combination of the dome C, having the opening C^6, and hollow rib C^4, and aperture C^5, with the casting D, having the steam passages D^1 D^2 D^3, the latter communicating with the passage C^5, substantially as specified. (4) The combination of the steam dome carrying the casting D, having the passages D^1 D^2 D^3, with the throttle E, adapted to close the latter passage, substantially as specified. (5) The combination with the dome C, of the casting D, secured thereon having the described steam passages leading to two steam chests, and the throttle E, substantially as specified. (6) The dome C, provided with the valve chests C^3, having apertured exterior walls, in combination with the cylinders I, having the projections H, substantially as specified. (7) The combination with the dome C, provided with the valve chests, interior hollow rib, and annular flange or bearing, of the casting D, having the described steam passages, the throttle E, and the governor F, the valve mechanism J J^1 J^2, the framework K^2, crosshead L, and piston rod M, substantially as specified. (8) The combination of the steam boiler, its steam dome, and a ball joint bearing between said boiler and steam dome substantially as and for the purpose described. (9) The combination of a steam dome and a steam chest having two of its walls within said dome, and a recessed portion, N, in the bottom of said steam chest, substantially as and for the purpose described.

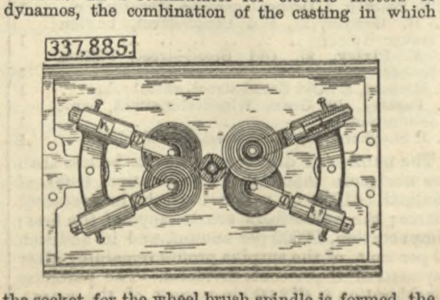
337,840



337,885. COMMUTATOR BRUSH, *Levi W. Stockwell, Cleveland, Ohio.—Filed February 26th, 1885.*

Claim.—In a commutator for electric motors or dynamos, the combination of the casting in which the socket for the wheel brush spindle is formed, the wheel-brush and its spindle, the collar and spring on the spindle, and the set screw.

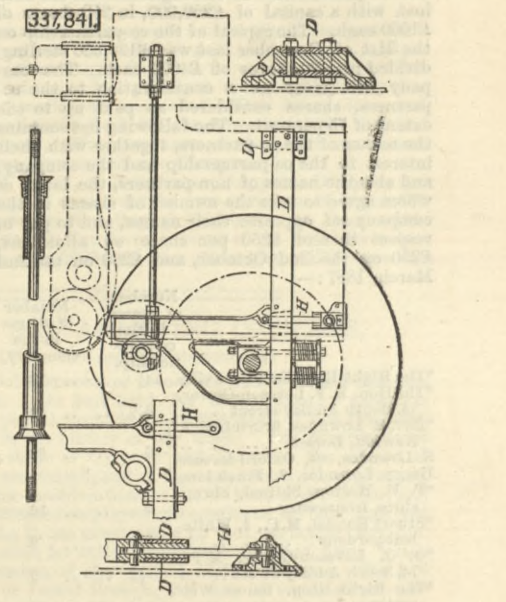
337,885



337,841. TRACTION ENGINE, *Frank F. Landis, Waynesborough, Pa.—Filed January 18th, 1886.*

Claim.—(1) In combination with a boiler, the engine frame rigidly secured to said boiler at its front end and movably secured to the housings or supporting frame, substantially as and for the purpose described. (2) The combination of a traction engine boiler, its housings, and sills D with brackets D', secured to the front end of the fire-box, and links H, having their lower end secured to the rear end of the fire-box and their upper end to the framework, substantially as described. (3) The combination of a traction engine boiler, its supporting frame, housings, and horizontal bar E^2, connecting said housings with the interlocking plates e and e^2, secured to the rear end of the boiler and to said horizontal bar, substantially as and for the purpose described. (4) The combination of a traction or portable engine boiler, its engine bed having three bearing points, a single rigid bearing to the boiler at the cylinder's end, and two sliding bearings at the opposite end, and connected to the supporting frame or housings, substantially as set forth.

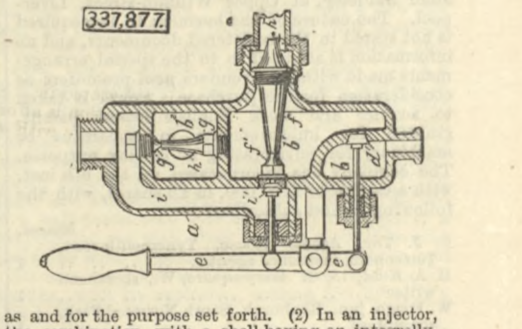
337,841



337,877. INJECTOR, *William J. Sherriff, Allegheny, Pa.—Filed September 26th, 1885.*

Claim.—(1) In an injector, the combination, with a shell, as a, having integrally-formed compartments, as b b^1 b^2, and a steam port, as i, of removable vertical lifting tubes, as g g^1, a supply pipe, as h, a steam inlet valve, as i^1, horizontal forcing tubes, as f f^1, a waste-water discharge valve, as d^1, and mechanism, substantially as described, for operating the valves as and for the purpose set forth. (2) In an injector, the combination, with a shell having an integrally-formed steam port and a waste water chamber, each provided with a valve seat, of valves, as i^1 and d^1, connected with an actuating lever fulcrumed between said valves, so that when one valve is open the other will be closed, substantially as described, and for the purpose stated.

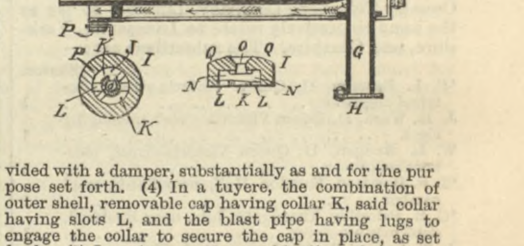
337,877



337,886. TUYERE, *Jacob Stoll, Milwaukee, Wis.—Filed May 2nd, 1883. Renewed August 10th, 1885.*

Claim.—(1) In a tuyere, the combination of the outer shell, removable cap, and the blast pipe having hollow leg, substantially as shown and described, for the purpose set forth. (2) The combination of outer shell, cap, and blast pipe having hollow leg, substantially as and for the purpose set forth. (3) The combination of outer shell, cap, and blast pipe having hollow leg provided with a damper, substantially as and for the purpose set forth. (4) In a tuyere, the combination of outer shell, removable cap having collar K, said collar having slots L, and the blast pipe having lugs to engage the collar to secure the cap in place, as set forth. (5) In a tuyere, the combination of shell A, pipe B, having hollow leg G, damper H, and lugs J, and the cap I, having chamber N, counterbored opening O, flange P, openings Q, and collar K, with slots or openings L, all substantially as shown and described, for the purpose set forth.

337,886



337,984. BARREL HEAD, *F. J. Oliver, Brooklyn, N.Y.—Filed January 22nd, 1886.*

Claim.—A barrel head consisting of three or more pieces, of which the centre one is halved, in combination with a locking piece swinging on a bolt attached to one half of the centrepiece, and with shoes secured to the staves of the barrel, substantially as shown and described.

337,984