THE DANUBE BRIDGE PROJECT.

No. I.

By Robert Hudson Graham.

In the month of August, 1882, the Roumanian Minister of Agriculture issued a circular inviting engineers to deliver competitive designs for two large metallic bridges, one to span the Danube main channel opposite the station of Cernavoda, the other to cross the Borcea branch in the vicinity of Fetesci. It was intended, by means of these two bridges and a viaduct or embankment over the Balta Islet, to connect the existing line of railway between Cernavoda and Constanta—Kustendjie—on the Black Sea, with a new line between Fetesci and Bucarest. Accompanying this invitation there was an official specification giving certain geological data concerning the stratification of the river bed, as well as the principal dimensions of the double bridge project. A stipulation was also added to the effect that before tendering each firm should make, for their own instruction and at their own expense, preliminary surveys and soundings of the channel, which operations were to be carried on under the personal superintendence of a Government engineer. With regard to the site, the Government allowed the engineer a certain latitude; but most of the firms adopted a line, suggested by the Government authorities, passing from near Fetesci to a point a little above Cernavoda. Some, however, chose a line somewhat further north, but still above Cernavoda, so as to profit by the hill which slopes gently towards, and ultimately vanishes, in the Cernavoda Valley; whilst others preferred the line stretching from below Cernavoda to Stelnica, which afforded, apart from other advantages, greater facilities for staging, erection, and the transfer of material. The bridges might be either high or low level, the minimum height of the former to be 30 metres and that of the latter 11 metres above flood datum.

The suspension was the only prohibited type of bridge. The line was to be single, with a separate footway 2 metres in width at the side of each bridge. Wind pressure must be assumed as 270 kilogs. per square metre—55 lb. per square foot—and the minimum temperature as 30 deg. Centigrade below zero. The working limits of stress were to be respectively; for steel, 10 to 14 kilogs. per square mm. (6·35 to 8·89 tons per square inch); wrought iron, 6 to 8 kilogs. per square mm. (3·8 to 5 tons per square inch); rolled or plate iron, 5 to 7·5 kilogs. per square mm. (3·17 to 4·76 tons per square inch); cast iron in compression, 6 to 7·5 kilogs. per square mm.; plate iron at supports, 3 to 3·5 kilogs. per square mm.; oak or pine wood, 0·6 to 0·8 kilogs. per square mm. The rest of the specification dealt chiefly with the final testing and inspection of the structures, the conditions of which were adapted to the standing orders of the French Government relatively to metallic bridges. Lastly, three premiums were offered for competition, namely, a first of 40,000f. (£1600); a second, of 30,000f. (£1200); and a third of 20,000f. (£800); each prize design to have a right of indemnity save that finally chosen by the Government as the most suitable project for the two structures. Also the successful engineer would be bound to adopt from other prize designs whatever parts might be deemed improvements upon his own. All tenders were to be sent in on or before the 1st day of June, 1883, but the date of delivery was afterwards postponed to the 1st of September of the same year, by which time designs had been received from the following eight firms:—(1) The Société des Batignolles—formerly Gouin et Cie.—Paris; (2) Messrs. Klein, Schmoll, and Gärtner, Vienna and Oberhausen-on-the-Ruhr; (3) Messrs. Holzmann and Co., Frankfort-on-the-Main, Union Dortmund, and Esslingen; (4) The Fives-Lille Company, Paris; (5) Messrs. Röthlisberger and Simons, Berne, in association with the Fives-Lille for this project; (6) M. G. Eiffel, Paris; (7) the Anciens Etablissements Cail, Paris; (8) the Société Anonyme Internationale, Braine le Comte and Brussels.

The jury called to judge the competition was composed of Inspector Frunza, president; Professor Collignon, of the Ecole des Ponts et Chaussées, Paris; Dr. Winkler, of the Berlin Polytechnic School; and Inspectors Yorceanu and Olanescu, with M. l'ingénieur Saligny as secretary. It will be seen that this committee, including amongst its members two well-known and leading continental authorities on bridgework and railway engineering, was eminently well-qualified to distinguish the order of merit in the several designs. The jury took six days to consider its decision, and to receive any additional explanation which the competitors might wish to make; when it agreed upon the unanimous opinion that none of the projects were worthy of a first premium. With regard to the bestowal of the second prize there was a difference of opinion, arising from the circumstance that the majority of the Commission, comprising Messrs. Collignon, Frunza, and Yorceanu, thought the semi-parabolic girder the most suitable type; whilst a minority, composed of Dr. Winkler and M. Olanescu, considered the arched rib the better adapted form of structure. Indeed the minority held a very strong opinion that the arch design of Messrs. Holzmann would have deserved the first prize, had they not neglected to present a certificate, duly signed by the Government engineer, showing that they had made the required survey and necessary soundings of the river bed.

After further consultation the jury decided to award no first premium, and to give the second to La Société Batignolles, for having delivered the best design, with wide spans, independent girders, masonry piers, and good serviceable cut-waters. The third premium was awarded to Messrs. Klein, Schmoll, and Gärtner, for having made a very conscientious study of the site, and for having delivered a design fully up to the requirements of modern science. A first honourable mention was accorded to Messrs. Holzmann and Co. for their bold, original, and ingenious project; and a second honourable mention to the Fives-Lille Company and their associates, Messrs. Röthlisberger and Simons, for their carefully worked-out designs.

After this short summary of the official specification and jury award, it may be useful to review some of the leading hydraulic principles and facts brought to light during the survey of the river bed. Those who may wish to learn more of the minute details of the competition should consult the excellent *brochure* of M. A. Gaedertz, chief of the Bureau Technique of the Roumanian Government Railways, entitled, "Concours pour la Construction d'un Pont sur le Danube à Cernavoda, Bucarest, 1884." The data touching the Danube channel proper are to be found in the reports of Sir Charles Hartley; those affecting the Borcea branch and the Balta Islet, in the account of the survey made by Messrs. Klein, Schmoll, and Gärtner. In this article we shall confine our attention to a description and discussion of the hydraulic features of the project; in subsequent papers a *résumé* will be given of the more instructive peculiarities of the several schemes, together with full-page illustrations.

As already stated, the object of the Roumanian Government, in the construction of these two bridges, was to effect a junction between the line from Cernavoda to the Black Sea and that projected between Fetesci and Bucarest, which would supersede the circuitous route by Varna and Rustchuk, as well as the tiresome passage of the Danube by steamboat. Moreover, the structure was calculated to occupy an important strategic position by establishing a new link between Western Roumania and the trans-Danubian province of Dobrudscha. A cross section of the Danube and its branch—the Borcea—in a line with the intended structure, is given in diagram Fig. 2. This diagram, taken in conjunction with Fig. 1, shows that the Balta Islet, which is submerged during flood discharge, separates the waters flowing through the main and Borcea branch channels. This feature represents one great difficulty of the problem. Another is that the river bed of the lower Danube is subject to continual shifting. Sand and gravel banks form and disappear and give an ever-varying direction to the open channel, the greatest irregularities occurring after a flood discharge.

In the period between May and November, 1882, Sir Charles Hartley, being consulting engineer to the European Commission, discovered that the level of the Danube River bed varied in places as much as 4·5 metres. Other soundings have proved a variation of fully 5 metres. This fact, together with the knowledge that an immense volume of water is there discharged at comparatively high velocities, will serve to give some idea of the abnormal character of the Danube current. Moreover, in the thawing season, the river carries with it vast masses of ice, which bear down upon and threaten to destroy every obstacle or structure raised by man.

During flood, the total surface breadth between Cernavoda and Fetesci is 14 kilometres, which includes the united waters of the Danube, Borcea, and Balta submersion. The chief features of the Danube Channel are described in a passage to be found in M. Gaedertz's *brochure*, page 6, of which we here give a literal rendering, in order to return to it later for the purposes of criticism:—"The valuable studies of the main Danube Channel near Cernavoda, made by Sir Charles Hartley, furnish the principal contributions to our knowledge of the river tract between Cernavoda and Fetesci; nevertheless, a perfect idea of its nature has only become possible, in consequence of the further investigation of Messrs. Klein, Schmoll, and Gärtner into the characters of the Borcea current and Balta Islet submersion. Taking a depth of average flow of 4 metres above Cernavoda datum, which is 17·11 metres above sea level, we obtain from the afore-mentioned observations the following dimensions of the Danube main channel:—Surface breadth at Cernavoda, 640 m.; sectional current area, 5925 sq. m.; wetted perimeter, 645·21 m.; hydraulic radius—deduced—9·183 m.; discharge, calculated by means of the Buât—Dubuat?—formula, 5810 cub. m.; whence is deduced the mean velocity, 0·981 m.; the declivity corresponding to the same data is 0·0000425.

In order to determine the volume of flood discharge through the main channel, Borcea branch, and Balta submersion, it is necessary to adopt an empiric formula as closely as possible allied with that suggested by Hagen for large rivers; namely,

$$v = 2{\cdot}425\sqrt{r}\ \sqrt[6]{i},$$

in which v represents the mean velocity, r the hydraulic radius, and i the slope or declivity. To bring this formula into harmony with the observations of Sir Charles Hartley, the coefficient 2·425 must be reduced to 1·733; so that for the Cernavoda-Fetesci cross section the mean velocity must be derived from the equation,

$$v = 1{\cdot}733\sqrt{r}\ \sqrt[6]{i}."$$

There would seem to be some lack of order and logical sequence in the reasoning set forth in the above extract, which after all may be chiefly due to a want of just appreciation on our part. Nevertheless, taking the first part of the passage where the dimensions of the channel, observed or calculated as the case may be, are set forth in order, it is not perfectly obvious how the discharge can be determined before the mean current velocity has been found, either by calculation, or, which is perhaps the better way, from a series of meter observations. In any case, the more rational method would be first to ascertain the slope and hydraulic radius by direct observation, and then, in the case of calculation, to deduce the mean velocity on the Chézy-Tadini assumption that it varies directly as $\sqrt{r\,i}$

FIG 3.

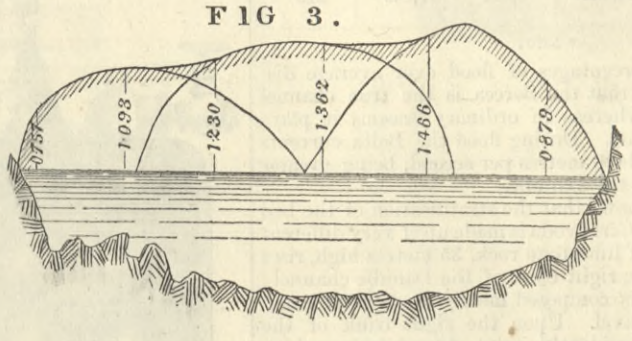


FIG 4.

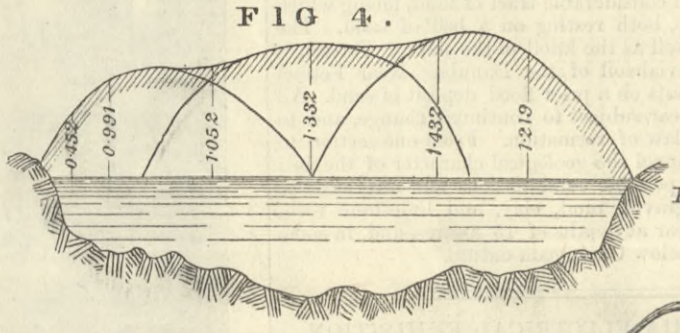
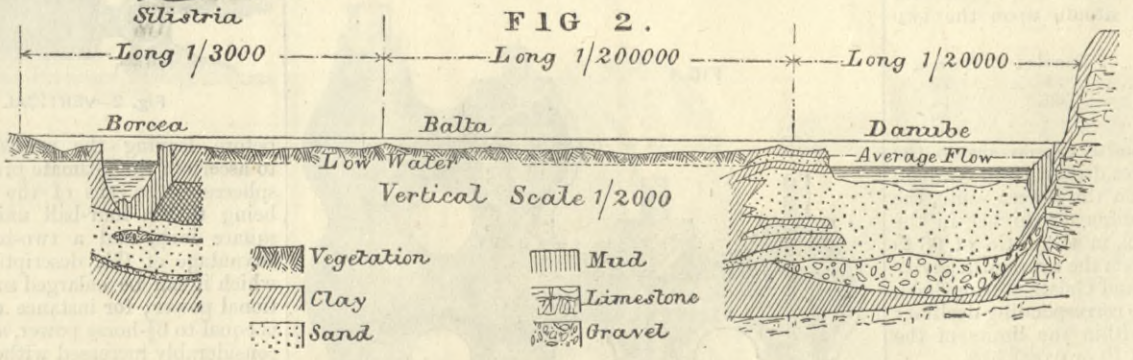


FIG 1.

FIG 2.



and inversely as the square root of the coefficient of water friction. Thus, finding the value of water friction in the light of the fourth series of Bazin's experiments, and the data furnished by Sir Charles Hartley's observations, the mean velocity should be 1·0964 instead of 0·981 metre per second, and therefore the discharge 6496 instead of 5810 cubic metres. Hence, unless the friction of water upon sand is greater in the Danube than in other rivers, the given discharge appears to be deficient. Even if, for the sake of comparison, we admit the maximum limit of water friction current amongst French and Italian engineers, the minimum mean velocity would be 0·98775 metre per second, and the consequent discharge 5852 cubic metres. But nothing here seems to warrant a high coefficient of friction.

Coming now to the second part of the extract, one fails to discover any *à-priori* reason why the mean velocity should vary as the square root of the hydraulic radius and the sixth root of the slope. Indeed, the swift rapidity with which the coefficient 2·425 is made to change so as to meet the requirements of the Danube current, would seem to prove that no such law of proportion obtains in all cases. Therefore it may be said that the generality of Hagen's assumption is, to say the least, very questionable; neither does the context make it perfectly clear whether or not M. Gaedertz wishes to extend the application of Hagen's formula so as to embrace in one equation the mean velocity of flow throughout the whole width of the Danube, Borcea, and Balta waters during flood discharge. We presume not; for any mean velocity so deduced would be unmistakeably false, insomuch that deep and shallow currents are not at all comparable, and, therefore, cannot be linked together in one and the same computation.

Velocity curves for sections, respectively 100 metres above and in the straight line between Fetesci and Cernavoda, are represented in diagrams, Figs. 3 and 4. It is matter for regret that some attempt was not made to compare surface velocities with velocities at all depths, so as to test the relations usually assumed to exist between surface, bottom, and mean current velocities. In order to meet and direct the outflow from the Danube across the Balta Islet into the Borcea Channel, it was proposed to erect a viaduct or else an embankment with stone footings. Below Cernavoda the question of outflow becomes less important, because there the two branches communicate by means of a series of large pools, so that the relative surface declivity is much reduced and the current has a less tendency to leave its natural channel.

The Balta Islet has almost a flat surface covered with a rich vegetation. The overflow may be said rather to percolate through than flow over it, for the water friction has gradually worn away a vast number of small channels which are more than filled during flood discharge. In fact, the Balta flood discharge may be arbitrarily assumed to consist of two superposed portions, the lower of which, being 1·7 metres in depth, serves only to fill these superficial hollows and water-cut channels; whilst the upper, being 0·8 metre in depth, may be regarded as the effective discharge traversing the Balta in a diagonal direction from the Danube to the Borcea. It may be here asked why the flood water takes this extraordinary course. The careful observations of Messrs. Klein, Schmoll, and Gärtner throw some light upon this question.

It will be seen by the help of the first diagram that the Borcea deviates from the Danube a little above Silistria, and lower down receives a second branch deviation, which separates from the main stream near Grabali. Then, after running a parallel course towards and considerably beyond Fetesci, the Borcea gradually approaches and ultimately rejoins the Danube near Gramasu, a little below Hirsova. The relative distances of places situate upon the two streams are as follows:—

	Danube.	Borcea.
Grabali to Hirsova	93	78
,, ,, Cernavoda	43	—
,, ,, Fetesci	—	32

Hence a point on the Borcea, opposite Cernavoda on the Danube, will be about 36 kilometres distant from Grabali. Owing to this saving of distance on the Borcea route, the surface levels of corresponding points are higher in the Borcea than in the Danube channel, in the ratio of 93 to 78 or 1·19 to 1. Opposite Cernavoda the average declivity is 0·0000425; between Cernavoda and Galatz, during flood, it rises to 0·0000435; wherefore the corresponding declivity in the Borcea would be equal, within the limits of the above assumption, to $0{\cdot}0000435 \times 1{\cdot}19$ or 0·0000518.

Now, the height of picket 192, where flood begins, is 25·09 metres above sea level; and the height of the point where the flood empties its waters into the Borcea, 4·8 kilometres below Fetesci, is only 24·13 metres above the sea. Consequently, there is a difference in level of 0·96 metre, and the distance between the two points being 15·6 kilometres, the relative surface declivity will be 0·0000638. Therefore, the simple explanation of the diagonal current direction is that, in passing from picket 192 to a point 4·8 kilometres below Fetesci, the flood water pursues the path of quickest descent. So great, indeed, is the velocity with which the water here precipitates itself into the Borcea, that in lapse of time it has caused a depression in the river bed of some 16 metres below Cernavoda datum. The hydraulic radius of the Borcea is 12·38 metres; its other dimensions, in a cross section near Fetesci, with a surface level of 4 metres above datum, are:

	Regular channel.	Flood land.
Surface breadth	212·6 m.	... 475 m.
Sectional area	2702·7 sq. m.	... 279 sq. m.
Wetted perimeter	218·3 m.	... 476 m.
Hydraulic radius	12·38 m.	... 0·586 m.

Assuming the Borcea slope to be uniform, its mean value, deduced from that of the main channel, would be $\frac{93}{78}$ (0·0000425) or 0·0000506; whence, as before in the case of the Danube current, we can deduce the mean velocities both of the flooded portion and the Borcea channel, properly so called. The declivity of the Borcea at its point of deviation from the Danube, and as far as the point where it receives the Grabali branch, is the same as that of the main current; but after that its value rapidly increases and attains a maximum near the middle of the branch, whence it gradually falls till at Gramasu, where the two streams rejoin, the slopes finally coincide. The total flood discharge through the Fetesci-Cernavoda section is 26,156 cubic metres, at Ismail Sir Charles Hartley makes it 28,300 cubic metres. The difference may be ascribed to the affluence of the rivers Sereth and Pruth. According to the investigations of Messrs. Klein, Schmoll, and Gärtner—recorded by M. Gaedertz—the comparative discharges of the main stream, the Borcea branch, and the Balta submersion, may be tabulated as follows:—

Branch.	Cubic metric volume.		Differences.	
	Flood.	Average.	Volume.	Percentage of average.
Danube	8,793	5,925*	2,868	48
Balta	10,028	—	10,028	—
Borcea	7,335	2,586	4,749	184
Total	26,156	8,511	17,645	219

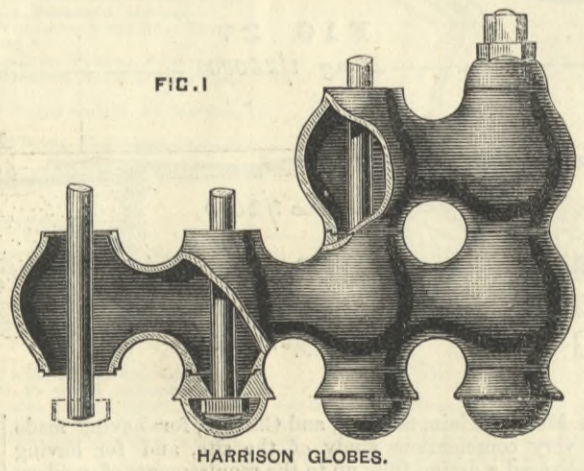
* 5810?

These differential percentages of flood over average discharge tend to prove that the Borcea is the true channel of flood discharge; whereas in ordinary seasons it plays only a subordinate part. During flood the Balta currents vary between 0·3 and 0·6 metres per second, being greater near the Borcea than the Danube.

Diagram Fig. 2 shows that the stratification of the bed between Fetesci and Cernavoda is made up of very different materials. A crag of limestone rock, 35 metres high, rises almost sheer upon the right bank of the Danube channel; whilst the river bed is composed mostly of clay and sand, superposed upon gravel. Upon the right bank of the Borcea there lies a considerable tract of mud, facing which on the left is clay, both resting on a bed of sand. The whole valley, as well as the knoll to the left of Fetesci, is formed of the alluvial soil of the Danube. Near Fetesci this alluvial soil rests on a prior flood deposit of sand. All these deposits appear subject to continual change, and to follow no general law of formation. From one section to another of the channel the geological character of the bed varies through all possible combinations and intermediate phases of sand, gravel, mud, clay, and limestone rock. Mud deposits appear at depths of 15 metres, and in some places 27 metres below Cernavoda datum.

PHILADELPHIA ELECTRICAL EXHIBITION.

The class of Mechanical Motors, which includes "steam, gas, water, heat, and wind engines," did not furnish any special novelty; besides, the three last sources of power were not represented, and the gas engines were on the well-known principles of Otto and Clerk. The largest exhibitor of steam engines was the Southwark Foundry and Machine Company, of Philadelphia, which had four Porter-Allen engines, together equal to 425-horse power, and one Southwark engine of 50-horse power and another of 100-horse power. This very fine exhibit contributed more power than was actually required, and at the same time astonished the engineer who is accustomed to rate the horse-power on a nominal basis, and who is at a loss to understand how an engine with two 18in. cylinders and 30in. stroke can be termed 300-horse power. The Porter-Allen type of horizontal engine is too well known to require further description, and the Southwark only differs in the construction of the valve gear. Both these engines are very durably constructed with special attention to oiling arrangements for continuous runs without stopping; and it was intended to work the 25-horse power engine for thirty consecutive days and nights, to test its suitability as a motor for an electrical supply station. These engines took steam from a common pipe, which was supplied by the Root, Babcock and Wilcox, and Harrison boilers, which are all of the sectional type, and represent the practice which is now general throughout the United States of employing this class of boiler in preference to the Cornish or locomotive and other allied forms. The Root boiler is well known, and the Edison installations of the electric light on the Holborn Viaduct and elsewhere have made us familiar with the Babcock, which has been described in connection with the Edison system. The Harrison boiler was first introduced some twenty years ago both in the United States and England, and American boilers on this principle are said to have been working satisfactorily for that period, but those boilers failed which were manufactured in this country, probably because the cast iron employed was inferior to that obtainable in America. It has recently been reintroduced by a Philadelphian firm, who exhibited two boilers set together and equalling 150-horse power, on the basis of evaporating 45 lb. of water into dry steam per hour for each nominal 1-horse power. The centennial rating, which is adopted by the engineer of the Exhibition, is 30 lb. of water per hour to the nominal horse-power, so these boilers would equal 225-horse power. The heating surface is produced by causing the fire to pass between a number of slabs consisting of spherical balls termed "units," and which are precisely the same both for the water and steam space. The construction of these units is clearly shown by reference to Fig. 1; also the method of connecting by means of a bolt, which passes through the entire length of the slab, its ends being protected from the heat by being surrounded either by steam or water, which collects in the spherical cap. The spheres are cast iron 8in. in diameter, the joint being made without red lead by simply allowing the male and female ends to butt together, after each has been accurately turned, the small amount of leakage which occurs at first is soon taken up. A special quality of cast iron, which resembles Bessemer steel, is used for the spheres. The ordinary working pressure is from 80 lb. to 100 lb. per square inch, each unit being tested to 350 lb.



HARRISON GLOBES.

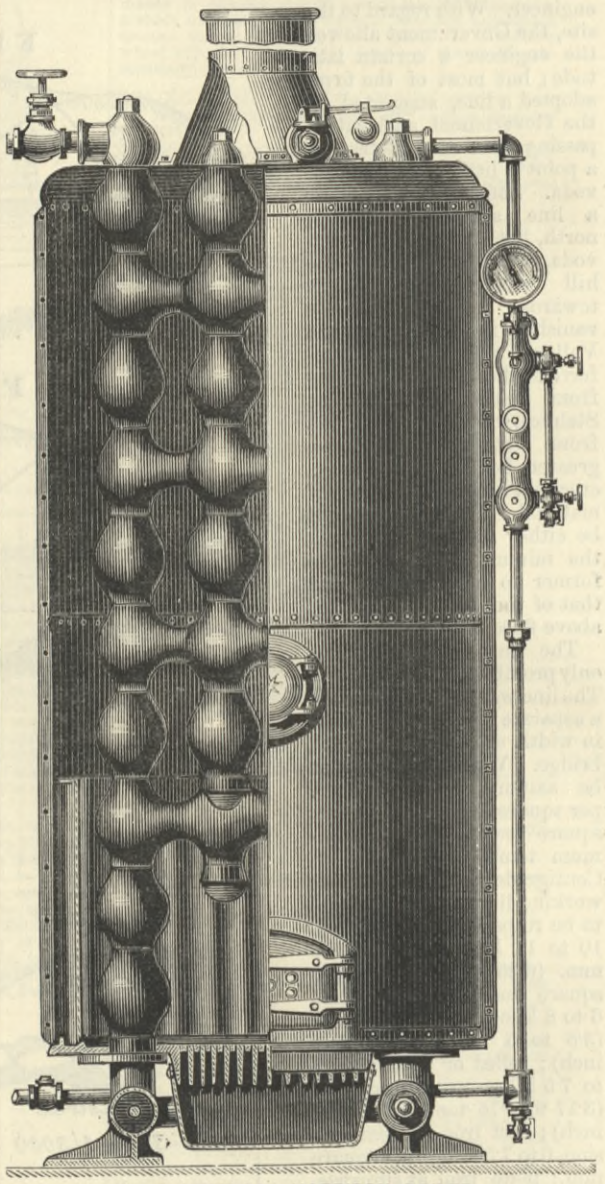
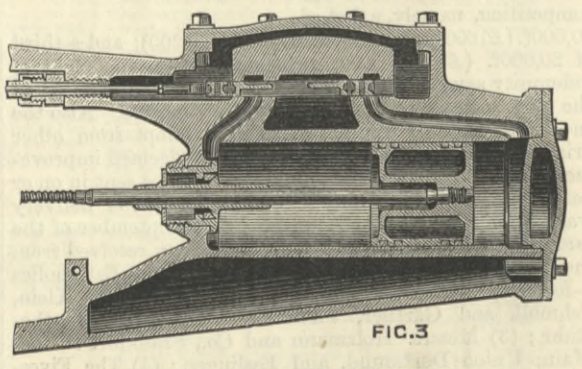


Fig. 2—VERTICAL HARRISON BOILER.

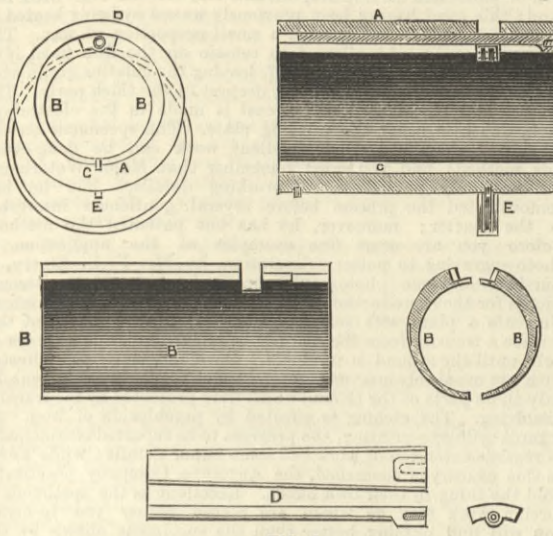
before leaving the works. An experiment was made to ascertain the ultimate pressure required to break these spheres by means of the hydraulic pump, the results being that a four-ball unit burst with 1400 lb. on the square inch, and a two-ball with 2200 lb. A special advantage of this description of boiler is the ease with which it can be enlarged so as to furnish steam for additional power; for instance one set of units termed a slab, is equal to 6¼-horse power, and the number of slabs can be considerably increased without interfering with the action of the boiler. A vertical form on the same principle is illustrated by Fig. 2. In this design the slabs are connected together and supported on the two hollow feet forming mud drums, which, being below the grate, are always accessible, and enable the sediment to be easily removed. The shell of the boiler is enclosed by a sheet iron casing made in halves and connected by bolts through angle iron at the sides, so that it can easily be removed for cleaning or examining the slabs. This vertical boiler was used to furnish steam for the Brotherhood three-cylinder engine, which drove the dynamo machine for the naval search light.



STRAIGHT LINE ENGINE CYLINDER.

We have recently illustrated and described the general arrangement of the straight line engine, and now

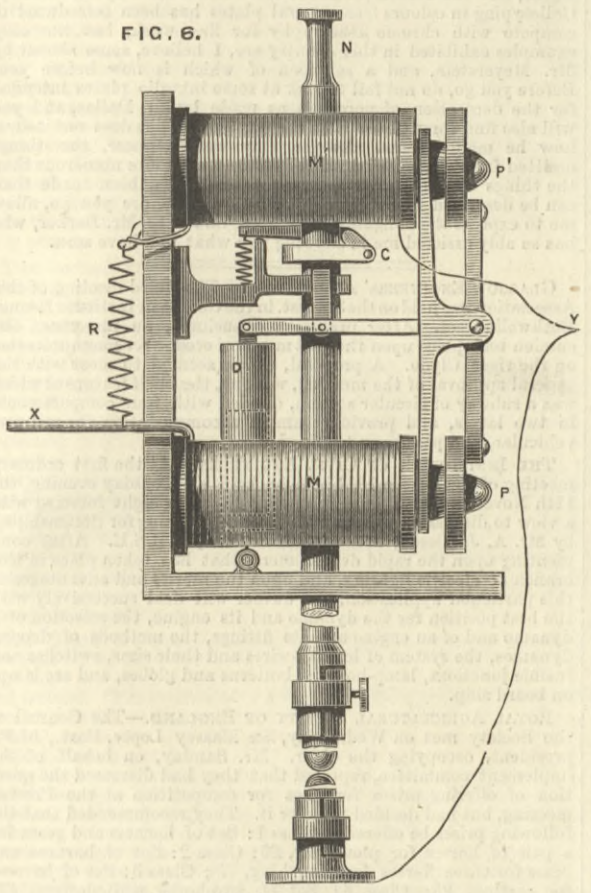
give a few of the special details in which it differs from the ordinary horizontal type. Fig. 3 is a horizontal section through the cylinder, which is cast in one piece with the frame and brackets for the shaft, as well as the steam chest and cylinder jacket. This appa-



FIC. 4.
STRAIGHT LINE JOURNAL BOXES.

rently expensive method of construction has the merit of remaining true when once made so, and certainly is very rigid. All the parts of this engine are made to gauge, and all the planing is done to what are known in Connecticut

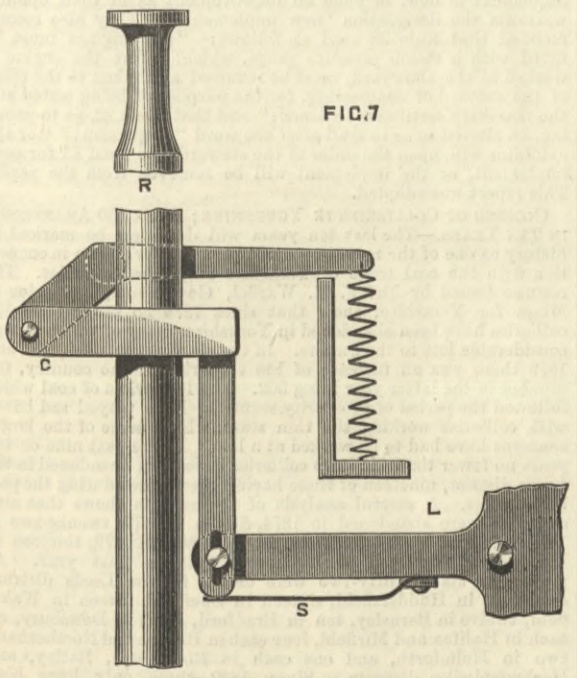
FIC. 6.



THE THOMSON-HOUSTON LAMP.

as "jigs" or metal templates, which engage the tool-holder when the work is cut to the required depth, and relieve the machinist from any liability to mistakes. The piston-rod and valve packings are simply Babbitt

FIC.7



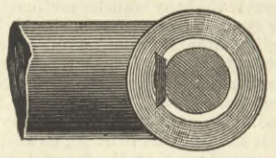
THOMSON CLUTCH.

metal bushings, with holes slightly larger than the rods, so as to be a free sliding fit; they rest on a spherical seat which is free to move in any direction; leakage of steam is prevented by the length of the bush; the contact being slight the wear is very small. The main journal boxes are of new design, and will be more easily understood by reference to the several views in Fig. 4. The boxes A consist of solid iron sleeves, which are bored out excentric to the shaft, and are then lined with Babitt metal pieces B, which make the bearing concentric. These pieces are retained in position by means of a feather C at bottom, and a brass wedge D at top. Narrow metal liners are introduced at the bottom, which can be removed and placed by the side of the wedge at the top, so that the metal pieces can be shifted down and the wedge-shaped opening closed. The oil escaping from the inner end of the main boxes is allowed to find its way into the crank and excentric sheave; that from the outer side is carried back and deposited in a pocket cast in the frame, into this recess metal rings E are allowed to drop, and are hung upon the shaft with their lower ends in the oil which, by reason of the rotary action of the shaft they lap up and thus lubricate the upper surfaces of the bearing. Space will not allow us to explain all the details of joints and pins and we must conclude our description of this fine sample of American tool work by drawing attention to the pivots of the links on the governor, which are anti-friction and made as shown by Fig. 5. The pins rolling on the flat surfaces of tempered steel not only reduce friction but avoid the necessity of oiling.

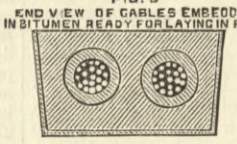
The arc lamps in the Thomson-Houston Electric Company's exhibition included several different forms, all of which may be described as of the differential clutch pattern, each however having certain details in the interior mechanism, ingeniously arranged to cover a wide field, and thus render imitation difficult without infringing patents. By Fig. 6 we illustrate the Thomson arc lamp, and in order clearly to show the principal working mechanism, we have omitted some of the unimportant details. The current enters at x, and passes round the electro-magnet M, a portion of it being diverted through the adjustable resistance R of hair-like wire to the magnet M', which is wound with fine wire. The arc is formed by the armature P being attracted by M, and thus raising the carbon rod by means of the clutch C, which also regulates and causes the rod to be dropped and the carbon to feed, by means of the shunt magnet M' acting on the armature P'. A dash-pot D prevents any violent shock; it simply consists of a brass cylinder in which is fitted a loose plunger, which compresses the air in the top portion, and is an improvement on the glycerine dash-pot employed with the old form of Brush lamps. It will be noticed that the carbon rod N is smaller at the top, the object of this is to allow the rod to slip past the clutch when the carbons are nearly consumed, and thus put out the light and prevent the accidental destruction of the carbon holders. The particular novelty in this lamp is the way in which the clutch is borne elastically, so as to cause its immediate re-closing when the rod begins to feed without any jerk, and with the same effect as if a train of wheels was employed. This action will be easily understood by referring to Fig. 7, which shows the clutch gear in detail. L is the magnet lever, S the spring under the clutch, and C the clutch with its elastic support. The electro-magnets in these lamps are similar to those used on the current regulator of the dynamo machine in that they are furnished with paraboloid poles which project into perforated armatures which are never allowed to touch the poles, so that the pull is the same whether the armature is hard up or away; the rod contact is shown by Fig. 8, and consists of a strip of copper cut into the form marked A, and then bent so as to encircle the carbon rod as shown at B. This lamp works very well, but requires extremely delicate adjustment, has to be worked with a long arc, and will only burn special carbons.

Besides a large number of series arc lamps having distinct mechanism from one another to illustrate the Thomson patents, an interesting feature of this exhibition was the arrangement of a 10-ampère arc light circuit, so that it could be divided into two branches at will, giving to each two series of small arc lights taking 5 ampères, or half the working current. To equalise the amount of current passing through each series, Professor Thomson leads the main line wire at the point where the current is divided round two massive iron poles connected together by a yoke piece; in fact, the divided circuit

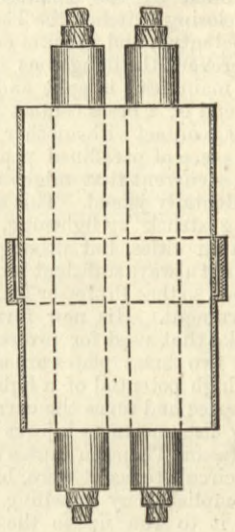
FIC. 5



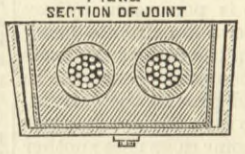
FIC. 9
END VIEW OF CABLES EMBEDDED IN BITUMEN READY FOR LAYING IN ROAD



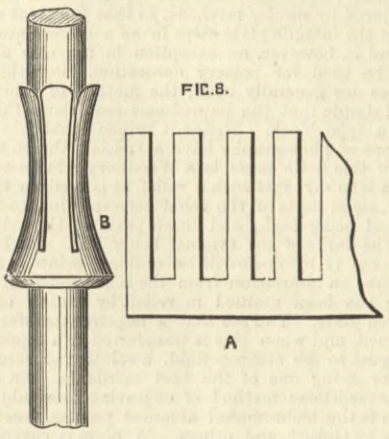
FIC.11
PLAN OF BOXES SHOWING JOINT



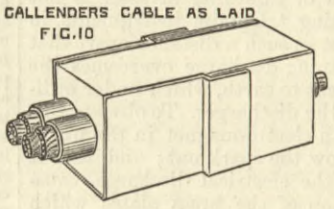
FIC.12
SECTION OF JOINT



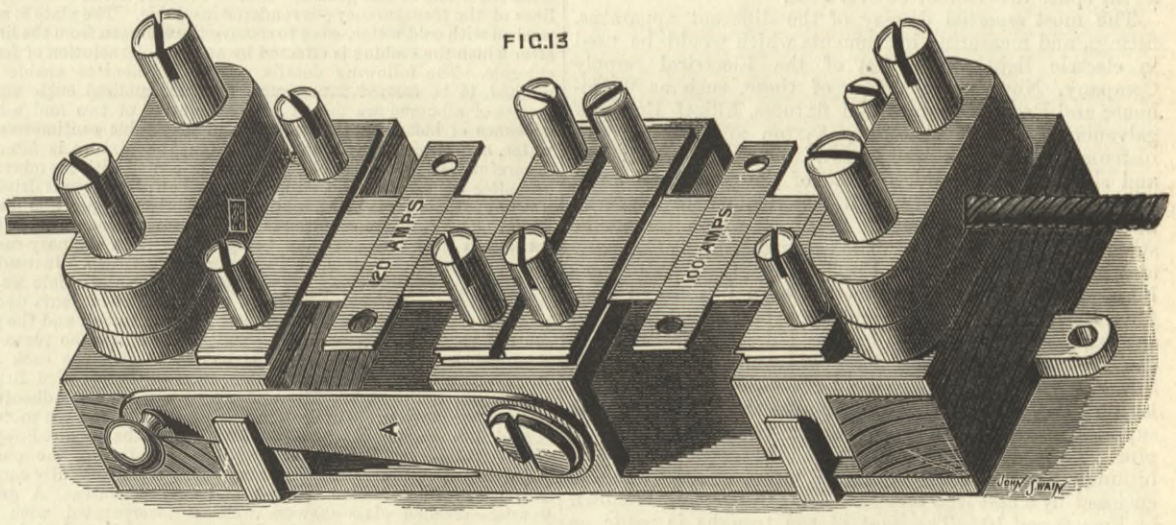
FIC.8.



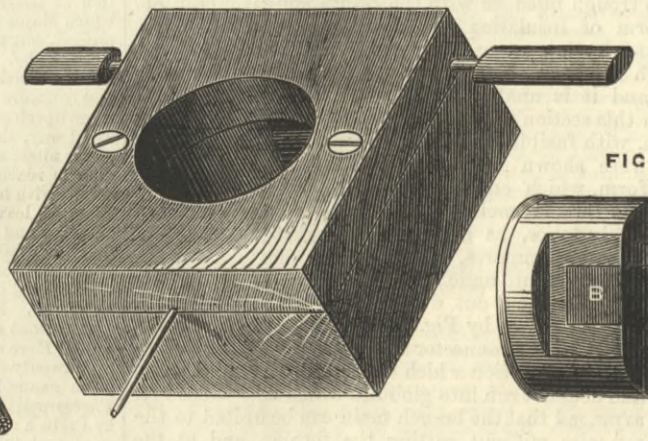
CALLENDERS CABLE AS LAID
FIC.10



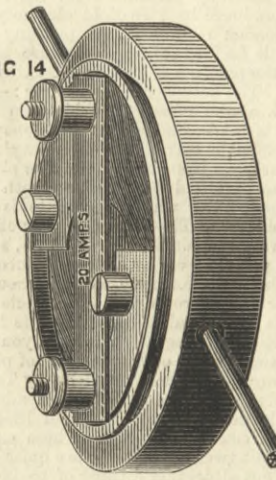
FIC.13



FIC 16

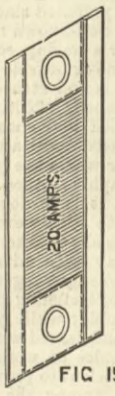


FIC 14



FIC 17

FIC 15



HEDGE'S CUT-OUTS

passes round an electro-magnet with extra large soft iron cores, which react on the current and equalise the amount of electricity passing round the two poles. By this simple arrangement, and with plenty of electro-motive force, the current may even be split into three circuits without the least fear of accident to any of the lamps in the event of those on one circuit being extinguished before those on the other, thus enabling the distribution of half and third power arc lights for street lighting, which could be placed in a far more economical manner than would be possible with the ordinary 2000-candle power lamps. Those who remember the early days of electric lighting, when the single Serrin lamp actuated by the Gramme machine was the only practical means of obtaining the electric illumination, may recall the experiments of the British Electric Light Company, who exhibited two Serrin lamps working in a split circuit. The apparatus by which this was accomplished was the invention of Mr. A. F. Blandy, and to all intents is the same disposition of an electro-magnet which we have just described as one of the novelties of the Philadelphia Exhibition. A great variety of electrical apparatus was exhibited by the Thomson-Houston Company, such as self-closing switches, the Thomson film cut-outs for increase in potential, and vacuum cut-outs for increase of current. To prevent the dangerous increase of electro-motive force, the main lead is split and a branch wire is connected to one end of a brass contact piece, which is prevented from actual contact with another wire leading to earth by means of a piece of paraffined paper, which is perforated by any excess current that might arise by two arc circuits being accidentally joined. This also acts in the case of the leads being struck by lightning, a very common occurrence in western cities, but although it would ground the current, it is not always sufficient protection to save the dynamo machines, so that Professor Thomson in some cases uses another instrument. His new form of lightning arrester is not unlike that used for protecting telegraph instruments, in that two brass plates are set at such a distance apart that the high potential of a lightning discharge overcomes the air space and turns the current to earth, which under ordinary circumstances injures the discharger. To obviate this Professor Thomson causes an electro-magnet in the working circuit to, as it were, blow the spark out; and this it accomplishes by repelling the electrical discharge, causing it to run up to the top of the brass plates which are purposely set at an increasing distance apart, with an air space that cannot be overcome.

The most assorted display of the different apparatus, fittings, and measuring instruments which would be used in electric lighting, is that of the Electrical Supply Company, New York. Many of these, such as Woodhouse and Rawson's lamps and fixtures, Elliott Brothers' galvanometers and rheostats, Ayrton and Perry's test instruments, are too well-known to require description, and show that England, in spite of the protective tariff, can compete successfully with America where a special branch of skilled labour is required which cannot be superseded by machinery. The Electrical Supply Company also showed, among other English inventions, Callender's bitumen core conductor, which has been introduced both for electric lighting and telephone purposes, with so much success that a large works has been erected specially for the manufacture of this form of cable in the United States. No special arrangement or conduit is required for laying this description of conductor in the streets, as it is supplied in lengths, which are laid in the ground like gas pipe. Each piece is made up of stranded copper wire with a bitumen core, surrounded with composition, the whole is enclosed by a cast iron trough. The arrangement is shown by Figs. 9 and 10. The joint of the troughs is made as illustrated by Figs. 11 and 12, the ends of the cable being carefully spliced together, re-covered with insulating material, and the trough filled in with the bituminous composition. This form of insulation appears to be well suited for a climate having an extreme range of temperature, as, although softened by heat, it does not run or change in shape and it is unaffected by cold. The electric light wires in this section were protected by Hedges' system of cut-outs, with fusible mica foils, and several new arrangements were shown in the same exhibit. Fig. 13 is a duplex form, which enables a spare fuse to be instantly substituted for that melted by turning the handle marked A. For instance, as shown the working fuse is set to melt with 100 ampères, and the spare one marked 120 would be thrown into action by causing A to bridge the gap. Fig. 14 is a cut-out designed for smaller currents, the mica foil is shown by Fig. 15, the fusible portion being shaded. Fig. 16 is a connector form of cut-out, and is constructed of a composition which adheres to the mica when melted, and does not run into globules which may cause fire. It is so arranged that the branch main can be united to the small lamp wire without cutting the former, and at the same time a very simple form of fusible connection, Fig. 17, can be inserted and be easily replaced if melted, by any person without special electrical knowledge. The United States Regulations with respect to the introduction of the electric light into buildings are much more strict than those supposed to be in use here. The insurance companies have united in many cities for the purpose of employing a duly qualified electric light inspector, who not only provides regulations as to the fixing of the wires, but also makes a systematic inspection of the fittings, and tests the safety fuses before he gives a certificate, which has to be shown to the insurance company. Where this system has been carried out for some time, there have been no fires due to the electric light, while previously there had been a very large number, especially in mills.

South Kensington Museum.—Visitors during the week ending Nov. 1st, 1884:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 12,906; mercantile marine, Indian section, and other collections, 3571. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 4 p.m., Museum, 1548; mercantile marine, Indian section, and other collections, 187. Total, 18,212. Average of corresponding week in former years, 15,915. Total from the opening of the Museum, 23,493,628.

RECENT IMPROVEMENTS IN PHOTO-MECHANICAL PRINTING METHODS.*

By Thomas Bolas, F.C.S.

Perhaps the most perfect mode of printing is from an incised or "cavity" plate, as by this method the most minute markings can be reproduced with a degree of perfection which is not attainable either in the case of lithography or typography; but what is, perhaps, of more importance, is the circumstance that by adjusting the depth of the cavities to the requirements of the subject, not only can the engraver of the plate determine which portions of the print shall be covered with ink, but he can also determine how much ink shall be devoted to each part of the subject. To put the case in another way, not only can the engraver plot out his subject in black and white, but, within certain limits, he can determine how black the lines shall be. Intaglio plates made by the aid of photography have been produced in great perfection by several methods, but up to the present time there has not been a very large market for them; partly, perhaps, from the considerable expense attending the work of printing from them. Intaglio plates are, even in the present day, generally printed from by hand; and this notwithstanding the fact that very excellent machines have been constructed for the purpose of plate printing. One may generally put it that any transfer method for the production of a lithographic or typographic surface may also be applied to the production of intaglio plates, it being merely necessary to make a transfer in which the whites and blacks are reversed, to put this down upon a copper or steel plate, and to etch away the uncovered parts by suitable means. It will be thus seen that, by the Ives method, and its modifications, intaglio plates may readily be made; but there is but little inducement to do so, as such plates will not give much better impressions than the typographic or lithographic surfaces produced by similar methods, so that the great expense of printing from the intaglio plate steps in as a determining circumstance. There is, however, an exception in the case of printing surfaces to be used for pottery decoration. For this purpose intaglio plates are generally used, the method of printing being so rough and simple that the impressions cost about the same as prints from a type block. Hence it happens that intaglio plates made by means of photography have a special value to the potter. On the bed of this little press is a Woodbury relief made from a positive, that is to say, just such a relief as is used for the stannotype method, those parts of the relief corresponding to the whites of the original being high, and those parts of the reliefs corresponding to the darks of the original being low. Mr. Barker has uniformly inked it by means of an ordinary printer's roller, and let me now take an impression from the inked relief on a sheet of paper which has been grained in relief by means of pressure against a ruled plate. You see that a negative transfer in stipple is thus obtained, and when this is transferred to a copper plate, it serves as a resist to the etching fluid, a solution of perchloride of iron in water being one of the best mordants. An extremely simple and expeditious method of engraving line subjects upon copper plates is the bichromated albumen process, practised with much success by Gobert and others. A plate is covered with a film of bichromated albumen, and exposed under a transparency, until the whole of the ground—that is the part not covered by the lines of the transparency—is rendered insoluble. The plate is next washed with cold water, so as to remove the albumen from the lines, after which the etching is effected by an alcoholic solution of ferric chloride. The following details will be sufficient to enable the method to be carried into practice. One hundred cubic centimetres of albumen are mixed with a solution of two and a-half grammes of bichromate of ammonia in fifty cubic centimetres of water, and after having been well beaten, the mixture is filtered. A carefully cleaned plate of copper is now coated with the mixture, and after the excess has been well drained off, the plate is dried at a very gentle heat, it being retained in a horizontal position meanwhile. The exposure required is by no means a long one, half a minute in moderate sunshine being sufficient in ordinary cases; but this must, of course, be learned by experience. Instead of developing—washing away the unaltered albumen—in plain water, it is better to use a weak solution of aniline red or magenta dye, as under these circumstances the ground becomes tinted, and the progress of the development can be watched. When the plate has been dried, nothing now remains but to varnish the back and edges with an ordinary black varnish, such as the so-called Brunswick black, and to etch. The etching bath is made by dissolving one part of perchloride of iron in five of alcohol, and ten minutes is generally a sufficient time for etching to the required depth. On the table are some early specimens illustrating the photo-engraving method of Mr. Woodbury—now so successfully carried into practice by Messrs. Goupil and Co., of Paris. A gritty powder—crushed glass answers well—is incorporated with the gelatine used for making the Woodbury relief, and a leaden reverse being taken by pressure from the rough relief, the leaden reverse is reproduced by a twofold electrotyping. This reproduction of the leaden reverse is the printing plate. The method which Major de La Nöe calls typogravure is in reality an intaglio process, but the printing is conducted as in the case of ordinary zincography. The details are as follows:—A prepared zinc plate is coated with a film of sensitive bitumen by well-known means, and exposure is made under a transparency or a tracing, so that when development is carried on with turpentine or benzole in the usual way, the lines alone are bare. The plate is now etched with dilute nitric-acid—1 and 40—until a depth of about a 250th of an inch is reached, after which the plate is dried and once more coated with bitumen. The ground is now polished off with a stick of charcoal, leaving the bitumen in the lines, after which the plate is gummed and printed from by the usual zincographic method. This process is admirable for map work, although it is obviously inapplicable for the reproduction of subjects with widely extended blacks; and it has the advantage that the lines show no tendency to spread. Before going any further, you may with advantage look back at some of the older examples of photo-engraving in half-tone. Here are some specimens done by Talbot's etching process over twenty-five years ago, and they are admirable; while yonder is an example done by Mr. Dallas in 1864, and issued with the *Photographic News* of that year. These examples of work done by Pretsch about twenty years ago are quite sufficient to prove that good work is not altogether a thing of to-day. Among the newer methods, that of Klic deserves special mention; and this specimen, which was issued with the "Year Book of Photography for 1882," will serve to show you how perfectly this method can render the lighter or more delicate shades of a photograph. Messrs. Annan Brothers, of Glasgow, are working the process commercially in this country, and they have turned out some admirable plates. Klic has not published his method, but it is said to be an etching process, and the following details are given in a recent number of the *Photographic News*:—"The process itself was a secret at first, but we are informed that the principle of working is as follows:—A copper plate is dusted with powdered asphalt, and the plate is heated, so that the asphalt becomes nearly melted. A negative carbon print is now transferred on to the copper plate, and the plate, now covered with the negative in carbon, is etched, at first by a strong solution of perchloride of iron, which penetrates only the thinnest parts of the picture; then by a weaker solution of the same salt, the solution etching through the thicker parts. By employing more and more diluted solutions, it is possible to etch through thicker and thicker layers of gelatine, so that only the high-lights remain unetched." On the table are some exquisitely fine plates made by Messrs. A. and W. Dawson, the managers of the Typographic Etching Company, these being reproductions of subjects after nature, and of difficult drawings in wash. Major Waterhouse has been remarkably successful, during the past few years, in making intaglio plates, and he has published the details of his method. The process is a modification of one introduced some time previously by Geymet, and it is based on the mechanical reticulation or breaking up of the Woodbury relief. A Woodbury relief is developed upon a plate of silvered copper—but the relief need not be nearly so high as that required for the Woodbury process; in fact, an ordinary carbon print will answer—and when the relief is taken out of the developing water it is dipped into a solution of potassium bichromate, drained and dusted over with fine sand; this sand having been previously waxed by being heated in an iron pot, and stirred up with a small proportion of wax. The layer of waxed sand is allowed to remain on the film until it is quite dry, when it is brushed off, leaving the gelatine granulated or pitted all over, the pits being deepest in the thick parts. The plate is now blackleaded, and a cast is made in the electrotype bath, this cast being the printing plate. The specimens on the table will show you what excellent work can be done with this method; and you must remember that Major Waterhouse has not only published full working details,† but he has demonstrated the process before several gentlemen interested in the matter; moreover, he has not patented the method. Before you are some fine examples of the application of photo-engraving to pottery decoration, by Mr. F. S. Emery, of Burslem—and one photographic method which this gentleman adopts for the reproduction of pottery designs is of special interest. He coats a plate with sensitive bitumen, puts down upon this surface a transfer from the plate to be reproduced, and exposes to light until the ground is insoluble. Development is now effected with the usual solvents—say, a mixture of turpentine and benzole, only those parts of the ground which were protected by the transfer dissolving. The etching is effected by perchloride of iron. As regards collotype printing, the progress to be reported is principally as regards extension of work and some minor details; while as far as this country is concerned, the Autotype Company practically hold the thing in their own hands. Excellent as the specimens of foreign work may be which are placed before you to-night, you will find nothing better than the specimens shown by the Autotype Company. In Germany, the steam press is largely applied to the rapid production of collotypes, and before you are drawings of the machine collotype press constructed by Messrs. Schmiers, Werner, and Stein, the most striking feature being the large number of rollers, used in order to ensure equal inking and damping. The transfer of collotypes to porcelain has been practised to a small extent, vitrifiable colours being dusted on afterwards, but the results obtained have not been very satisfactory. Collotyping in colours from several plates has been introduced to compete with chromo-lithography for fine work, but the only examples exhibited in this country are, I believe, some shown by Mr. Meyerstein, and a selection of which is now before you. Before you go, do not fail to look at some intaglio plates intended for the decoration of porcelain as made by Mr. Dallas, and you will also find some prints from them. Mr. Dallas does not tell us how he makes them. As you may well suppose, the things omitted from this short course of lectures are more numerous than the things discussed; far more progress having been made than can be described in three hours. You will, before you go, allow me to express the obligation we are all under to Mr. Barker, who has so ably assisted me in showing you what you have seen.

* Cantor Lecture, delivered Monday, February 11th, 1884.

† *Photographic News*, 1880, p. 568.

Glasgow Engineers' Association.—The third meeting of this Association was held on the 3rd inst. in the Christian Institute Rooms, Bothwell-street. After preliminary business, an important discussion took place upon the best means of cross-over communication on the river Clyde. A proposal, which seemed to meet with the general approval of the meeting, was one, the chief feature of which was a subway of circular section, divided with four compartments in two levels, and providing ample accommodation for railway, vehicular, and passenger traffic.

The Institution of Civil Engineers.—At the first ordinary meeting of the session 1884-5, to be held on Tuesday evening, the 11th November, at 8 p.m., the paper to be brought forward with a view to discussion will be "On Electric Lighting for Steamships," by Mr. A. Jamieson, Assoc. M. Inst. C.E., F.R.S.E. After commenting upon the rapid development that has taken place in this branch of electric lighting, and upon the merits and advantages of this particular application, the author will deal successively with the best position for the dynamo and its engine, the selection of a dynamo and of an engine and its fittings, the methods of driving dynamos, the system of leading-wires and their sizes, switches and fusible junctions, lamp-holders, lanterns and globes, and arc lamps on board ship.

Royal Agricultural Society of England.—The Council of the Society met on Wednesday, Sir Massey Lopes, Bart., M.P., president, occupying the chair. Mr. Sanday, on behalf of the implement committee, reported that they had discussed the question of offering prizes for silos for competition at the Preston meeting, but had decided to defer it. They recommended that the following prizes be offered:—Class 1: Set of harness and gears for a pair of horses for ploughing, £5; Class 2: Set of harness and gears for three horses for ploughing, £5; Class 3: Set of harness for carting, £5; Class 4: Set of two-horse whippletrees, £2; Class 5: Set of three-horse whippletrees, £2; Class 6: Set of four-horse whippletrees, £2. The committee had revised the regulations for the exhibition of implements, and they recommended the adoption of a new rule as follows:—"That a fee of £1 be charged for every implement entered as a 'new implement,' the fee to be returned if the judges report to the stewards that the implement is new, or such an improvement as in their opinion warrants the designation 'new implement.'" They also recommended that Rule 33 read as follows:—"All engines must be fitted with a steam pressure gauge, which, before the engine is worked in the showyard, must be removed and taken to the office of the steward of engineering, for the purpose of being tested and the necessary certificate obtained;" and that Rule 22, as to painting, be altered so as to read after the word "inspection:" "or the exhibitor will, upon the order of the stewards, be fined £1 for each implement, or the implement will be removed from the yard." This report was adopted.

Closing of Collieries in Yorkshire; Over 150 Abandoned in Ten Years.—The last ten years will doubtless be marked in history as one of the most important periods ever known in connection with the coal trade of Yorkshire and other counties. The returns issued by Mr. F. R. Wardel, Government Inspector of Mines for Yorkshire, show that since 1874 no fewer than 155 collieries have been abandoned in Yorkshire, many of which caused considerable loss to the owners. In the six years between 1870 and 1876 there was an increase of 146 collieries in the country, the number in the latter year being 562. The low prices of coal which followed the period of prosperity seems to have played sad havoc with collieries working the thin seam, whilst some of the larger concerns have had to be worked at a loss. In the past nine or ten years no fewer than fifty-two collieries have been abandoned in the Leeds district, nineteen of these having been closed during the past three years. A careful analysis of the reports shows that nine collieries were abandoned in 1874, fifteen in 1875, twenty-two in 1876, thirty in 1877, twenty-one in 1878, ten in 1879, thirteen in 1880-1, and fourteen in 1882, and thirteen last year. As previously stated, fifty-two were closed in the Leeds district, seventeen in Huddersfield, sixteen in Sheffield, fifteen in Wakefield, twelve in Barnsley, ten in Bradford, eight in Dewsbury, six each in Halifax and Mirfield, four each in Birstal and Northerham, two in Holmforth, and one each in Robertown, Batley, and Heckmondwike districts. Since 1880 three only have been abandoned in the Barnsley district, and these were small concerns. Notwithstanding the decrease in the number of collieries, the output has materially increased. In 1870 the quantity raised was only 10,606,604 tons, whereas ten years later it had increased to 17,468,536 tons. In the previous ten years, between 1860 and 1870, the progress made was very slight. In the former year 387 collieries in Yorkshire produced 9,284,000, whilst in 1870, 416 collieries raised 1,322,604 tons more coal.

RAILWAY MATTERS.

THE Russian Minister of War has announced a competition for prizes of £100 and £50 respectively, to be given for an improved model of a railway truck for the transport of troops and horses. The plans are to be sent in by the 1st—13th—of next August.

MESSRS. JOHN LYSAGHT, of Bristol, Wolverhampton, London, &c., have just completed a contract for the supply and delivery of forty goods sheds for a foreign railway company. The order was given out on 17th September; time occupied, six weeks; quantity of materials, 1200 tons.

AN influential deputation has waited upon Sir James Ramsden, managing director of the Furness Railways, and submitted to him plans of a line starting near Haverthwaite, on the Lakeside branch of the Furness line, and taking the west side of Lake Windermere to Ambleside. Sir J. Ramsden promised to submit the scheme to the directors at an early date.

THE Paris, Lyons, and Mediterranean Railway Company has been instructed to examine a project to be submitted to the three States interested, namely, France, Italy, and Switzerland, and to furnish an estimate of the amount at which it would itself undertake the achievement of a Simplon tunnel on condition of a proportionate grant from each of these three States.

A NEW branch line from Branxholme to Casterton, in the colony of New South Wales, has just been opened for traffic. Several bridges have had to be constructed on this line, one carrying the line over the river Wannon, having five openings of 30ft. each, and sixty-seven of 15ft. each; while another bridge over the Glenelg has twelve openings of 30ft. each and sixty-three of 15ft. each, these being two of the longest bridges in the colony. Some of the earthworks, both cuttings and embankments, are of an extensive and costly character, the measurement of the largest in each case being about 112,000 cubic yards. The steepest gradient is 1 in 40, and the sharpest curve has a radius of 20 chains. A new railway line from the Spencer-street terminus, Melbourne, to Brunswick and Coburg, a distance of 5 miles and 7 chains, was opened for traffic on September 8th. Its construction cost £35,000.

THE Manchester goods express, leaving that city at 9.15 p.m., was wrecked near Oughtibridge station, on the Manchester, Sheffield, and Lincolnshire line, on Saturday morning. It consisted of thirty-seven vehicles, eleven of which were completely destroyed, and two others partially damaged. A brake block fell off a Great Northern wagon across the metals and threw the wagon off the line. On reaching the crossings near the west signal-box the wagon took the direction of the siding, at which point the strain caused the coupling hook of the engine to break; then the thirteen wagons toppled over into a heap. The main line was blocked for seven hours, 70 yards of road were badly damaged, and 300 chairs broken. Fortunately, the Grimsby fish express was delayed at Sheffield detaching coaches, otherwise it would, in all probability, have ran into the wrecked wagons, with grave consequences. As it is, the damage to rolling stock, permanent way, and goods was very serious.

THE German Railway Union finds its experiments in the way of round-trip—or rather circular trip—tickets at reduced rates for summer excursion travel a great success, and is extending them The excursionist is practically allowed to lay out his own route anywhere he pleases on the lines of the Union, subject only to the following restrictions:—(1) The distance traversed must be not less than 600 kilometres—370 miles. (2) It must form for the most part a circular tour, as distinct from a mere journey out and back over the same lines. (3) It must constitute a closed circuit, beginning and ending at the same point. Such tickets are furnished at all prominent stations at four hours' notice; they are good for five weeks from the date of issue. The reduction from the regular rates is very considerable. Liberal as these terms have been, they are still further extended by a recent vote of the Union. The third point, making a closed circuit obligatory, was often inconvenient. In future they are to be given the privileges of the circular-trip ticket, even though they arrange their outward journey to one point on the frontier, and begin their homeward journey from another.

THE Board of Trade returns just published, giving the results of a year's working of the railways of the United Kingdom, shows that there are 18,681 miles of railway open in England, Scotland, and Ireland. The number of miles run by passenger trains in the twelve months ending December last was 138,176,940, while mineral trains ran 127,983,253 miles; mixed trains, 2,737,043 miles, making a grand total of 268,897,236 miles run. To accomplish this enormous mileage, there are in use 14,469 locomotives, 32,304 carriages for passengers, and 458,357 vans, wagons, and vehicles, besides a very large number of wagons and vehicles owned by private individuals and by other than railway corporations. As regards the traffic, the returns show that in regard to passengers there were 36,387,877 first-class bookings, bringing in £3,670,053; 66,096,784 second-class bookings, earning £3,329,744; and no less than 581,233,476 third-class bookings, adding £17,050,064 to the revenue. In addition to this there were 632,050 season tickets issued, yielding £1,692,591, while excess luggage, mails, &c., earned £3,766,281, bringing up the total receipts from passenger trains to £29,508,733.

MODERN American methods of handling freight have forced themselves even upon the most conservative of countries. The *Railroad Gazette* says transportation of grain in bulk was introduced last year by an Austrian road which connects the railroads of South-western Russia with the German roads. In spite of the fact that the break of gauge at the Russian frontier has compelled a transfer of the grain, the method has been approved. Now the same system is being adopted by Hungary. Hungary has a large export trade of barley to the Mediterrancan, *viâ* Adriatic ports. The Mediterranean boats seem to have been in the habit of storing grain in bulk, even when the railroads brought it in bags; so that the change ought to bring even more than usual profit on the through traffic by rail and water combined. Meantime, at a recent conference between Russian and Austrian roads, a proposal was made to undertake the carriage of petroleum on a large scale in tank cars. The Russians and the Hungarians seem to have been ready to try it at once; but the Austrians were quite overwhelmed by the proposal, and reserved their decision until they should have time to study the probable effects of such an innovation.

AT the Technical Convention of the German Railway Union last July a report on preserved sleepers was rendered, continuing the record from a report some years ago which we have published. Of the railways answering the circular of inquiry sent out by the committee, thirty-four used preserved sleepers now, against twenty-four in 1868. The number of railways using each of the methods of preservation in 1865, 1868, 1878, and 1884 has been :—

	1865.	1868.	1878.	1884.
Sulphate of copper	15	6	5	1
Sulphate of iron and zinc	1	—	—	—
Sulphate of barium and oxydul of iron	2	—	—	—
Corrosive sublimate	3	6	8	4
Chloride of zinc	8	7	20	22
Creosote	4	5	13	11
Chloride of zinc and creosote mixed	—	—	4	7
Vapour of creosote (Paradis' patent)	—	—	—	1
Vapour of creosote and creosote (Blythe's system)	—	—	1	1
Antisepticum under pressure	—	—	—	1

Thus sulphate of copper, which was the prevailing method used in 1865, is now used by but one railway, but the use of chloride of zinc has extended until it prevails, and alone or in combination with creosote is used by twenty-nine out of forty-eight railways which use any preservative. Creosote alone, however, is still extensively used, though less so than in 1878. The extension of the use of chloride of zinc and creosote mixed indicates that there has not been entire satisfaction with either used alone.

NOTES AND MEMORANDA.

THE deaths registered last week in twenty-eight great towns of England and Wales corresponded to an annual rate of 20·6 per 1000 of their aggregate population, which is estimated at 8,762,354 persons in the middle of this year.

IN speaking of the kerosene mineral from Joadja Creek mine, near Berrima, Mr. Dixon, analytical chemist, Sydney, says:—"This mineral resembles the Boghead mineral from Scotland, but is considerably lighter, having a specific gravity of 1·098 against 1·20. The yield of volatile hydrocarbons is much greater than from even picked specimens of Boghead, whilst the ash is only half as great as in that mineral."

AS a means of producing an artificial sea atmosphere, a foreign contemporary suggests the use of a solution of peroxide of hydrogen containing 1 per cent. of ozonic ether, iodine to saturation, and 2·50 per cent. of sea salt. The solution placed in a steam or hand spray diffuser can be distributed in the finest spray in a room at the rate of 2 fluid ounces in a quarter of an hour. It communicates a pleasant sea odour, and is said to be as good a purifier of a sick room ever used, and a powerful disinfectant.

IN London, last week, 2745 births and 1503 deaths were registered. Allowing for increase of population, the births were 124 and the deaths 118 below the average numbers in the corresponding weeks of the last ten years. The annual death-rate from all causes, which had been 19·7 and 19·0 in the two preceding weeks, rose last week to 19·5. During the first five weeks of the current quarter, the death-rate averaged 18·6 per 1000, against 20·8, 19·8, and 18·4 in the corresponding periods of 1881, 1882, and 1883.

DURING the week ending October 11th, 1884, in twenty-seven cities of the United States, having an aggregate population of 6,214,300, there were 2515 deaths, which is equivalent to an annual death-rate of 21·0 per 1000, a decrease of 0·5 from that of the previous week. The deaths under five years of age were equal to 41·9 per cent. of the total mortality. The rate in the North Atlantic cities was 20·8; in the Eastern cities, 21·4; in the Lake cities, 18·6; in the River cities, 21·6; and in the Southern cities for the whites 18·2, and for the coloured 35·0 per 1000.

AN official report says:—"Titaniferous iron is abundant in New South Wales. It is found usually with alluvial gold; as at Ophir, Mudgee, and Wellington, in the county of Wellington; Bathurst; Bingera, county of Murchison; and Uralla, county of Sandon, in the diamond drift. Large rolled masses occur at Uralla. Ilmenite, menaccanite, nigrine, and iserine are said to occur with gold, garnets, and chrysolites in the Five-mile Flat Creek, Cudgegong River, in the Lachlan and at Talbragar, with magnetite; also near Wagga Wagga, county of Wynyard, and the Rocky River, county of Hardinge."

"A REDETERMINATION of the Atomic Weight of Cerium" was given at Montreal by H. Robinson, B.A., Cambridge. Cerous chloride was prepared by passing hydrochloric acid over cerium oxalate at first gently heated and afterwards raised to redness. The solution of pure chloride was added to a pure solution of silver nitrate, and then dilute solution of silver nitrate was added from a weighed bulb, until the precipitation of chlorine was complete. The liquids were illuminated by yellow light only during the precipitation. As a mean of seven closely concordant results, the atomic weight of cerium is given as 140·2593, that of silver being 107·93.

SOME idea of the amount of engineering employment afforded by brewing trades may be gathered from the following statistics:—According to a report of the internal revenue department of the United States, the amount of beer which paid taxes in the States last year was 588,000,000 gals. Add to this the beer exported and evading the tax, and the amount was 600,000,000 gals. The United States now ranks third in the list of beer-producing countries in the world. Although her breweries are few in number compared with those of other countries, she yet makes two-thirds as much beer as England, whose breweries are almost ten times as many. England is at the head of all beer-producing countries, with 27,000 breweries and a product of 990,000,000 gals. annually; while Germany, with 25,000 breweries, makes 900,000,000 gals. yearly. The United States, with only 3000 breweries, makes about 600,000,000 gals. per annum. Then come France, with 3000 breweries, and a production of 157,500,000 gals.; and Austria and Hungary, with 2093 breweries, but a production of 280,000,000 gals. Belgium has 1250 breweries, which produced last year 210,250,000 gals.; Holland, 500 breweries, producing 34,000,000 gals.; Russia, 480 breweries, producing 8,000,000 gals.; Switzerland, 423 breweries, producing 13,500,000 gals.; Denmark, 250 breweries, producing 28,000,000 gals.; Sweden, 220 breweries, producing 21,000,000 gals.: and Italy, 150 breweries, producing only 4,000,000 gals. Nearly 80,000 persons are engaged in brewing lager beer in the United States.

A PAPER was read at Montreal "On Evaporation and Dissociation," by Professor William Ramsay and S. Young, D.Sc. The authors described experiments made with the object of ascertaining whether the coincidence of the curves which represent the vapour-pressures of stable solid and liquid substances at different temperatures with those indicating the maximum temperatures attainable by the same substances at different pressures, when evaporating with a free surface, holds good also for substances which dissociate in their passage to the gaseous state. The substances examined were chloral hydrate, ammonium carbamate, phthalic acid, succinic acid, aldehyde ammonia, ammonium chloride, nitric peroxide, and acetic acid. It was found that, with chloral hydrate and ammonium carbamate, which cannot exist at all in the gaseous state, the temperatures of volatilisation do not form a curve. When the dissociation was considerable, but not complete, as in the case of phthalic and succinic acids, an indication of a curve was observed at low pressures, but it differed widely both in form and position from that representing the vapour pressures or pressures of dissociation. As the dissociation increases the curves approach each other more closely, and they appear to be coincident in the case of ammonium chloride and nitric peroxide within the limits of temperature at which observations were made, and at which the amount of dissociation is probably small. With acetic acid very numerous observations proved the perfect coincidence of the curves.

IN a recent paper by M. Planté, he gives the result of some experiments made to arrive at the cause and explanation of ball lightning; he was led to these experiments by having one of his mica condensers destroyed by a similar phenomenon. He charged one of his condensers from his secondary battery of 890 pairs, when the condenser was pierced, and instead of a bright spark a small incandescent globule was formed, which moved slowly over the surface of the condenser, following the parts where the insulating layer had least resistance, and destroying the metal film; the path being, *Nature* says, most curious and erratic. This motion continued and the globule lasted one or two minutes, until the batteries ran down. In the case of a condenser in which the insulating material was ebonite, a sound was emitted similar to a toothed wheel being rapidly rotated against a piece of cardboard or sheet metal; at the same time there was a strong smell similar to that produced when ebonite is burnt. M. Planté repeated this experiment with 1600 secondary cells, which gave an electromotive force of 46,000 volts, and obtained a similar but much more complicated result. The second experiment made was to make a condenser of two flat pads of filter paper moistened with distilled water and brought near together so as to form an air condenser; now on connecting this condenser with his battery he obtained an incandescent globule which moved about between the pads and passed from one to the other. In this case he noticed that if the pads became dry at any point the globule disappeared, but either appeared at some other point, or at the same point again, as soon as it again became damp. In this experiment he found that the globule lasted a much greater time than in the case of the mica condenser, which fact was owing to the greater resistance in the condenser plates, which did not allow the battery to discharge so rapidly.

MISCELLANEA.

THE death is announced of Mr. Henry J. Jackson, superintendent engineer to the General Steam Navigation Company, at their works, Deptford.

MESSRS. MARSHALL, SONS, AND CO., of Gainsborough, have opened an important branch establishment in Marshall's-buildings, Farringdon-road, E.C.

A LIFE-SIZE portrait in oils of Sir W. G. Armstrong, subscribed for by the public, in recognition of his many acts of munificence and philanthropy to the town, and of his eminence as a citizen and inventor, has been presented to the Mayor of Newcastle on behalf of the city. The portrait was painted by Miss Mary Miller.

AT the first meeting of the Institution of Civil Engineers for the session 1884-5 a paper on an electrical subject will be read; and in consideration of the all-embracing character of the Institution as representing civilian engineers, it is intended by the Council that the papers selected for reading shall be varied as much as possible.

FOR some time preparations have been in progress for lighting Temesvar, a Vienna correspondent says, by electricity. The works are now completed, and on the 26th ult. all the street lamps were burning with half, and on the 27th with full power. The result is entirely satisfactory. The gas will be done away with, and the illumination will be given exclusively by electricity,

WE understand that the Stanners Close Steel Company has decided to extend its electric light plant by the addition of some ten Brush arc lamps, six of which are now being erected. As this firm have been employing the light for some time, the present extension speaks well for its success. The work is being carried out by the Hammond Electric Light and Power Supply Company.

AT the Agricultural and Manufacturing Exhibition, just held at Odessa, Messrs. Ransomes, Sims, and Jefferies have received the diploma of honour—the highest prize obtainable—which has been awarded them for the excellence and varied character of their agricultural machines and implements, and in recognition of the care and completeness with which they have adapted their manufactures to the requirements of the Russian agriculturists.

IT has been said, though probably quite untruly, that a change is likely to be made in the Patent-office Sales Department, whereby it will be possible to obtain a patent specification on the day of application. Usually with the present system of clerks everywhere, and a division of labour that is infinite, it takes so long to get sixpennyworth of current patent literature that purchasers go away with the idea that it was a day ago that they entered the place.

CHALK has been struck at the depth of 524ft. by a tube well, which Messrs. Le Grand and Sutcliff, of London, are boring for Mr. R. L. Curtis, at Vange, near Pitsea, in Essex. Much uncertainty existed as to the depth necessary to go to reach the chalk in this locality. The London clay extended to 395ft., and the lower tertiaries are altogether 129ft. thick. It is expected that the total depth to be bored to obtain a good supply of water will be somewhere over 600ft., and at the present rate of progress it is anticipated this will be completed within the next three weeks.

A PAPER on "The Testing of Fans" was contributed by Professor A. S. Herschel to a meeting on Monday of the South Staffordshire Institute of Mining Engineers. During the evening the Rev. Mr. Capel invited the members to see an 11ft. fan at work at the Haunch Wood Colliery, near Nuneaton, capable of passing 70,000ft. of air per minute. A discussion upon Professor Herschel's paper followed, and it was agreed that the subject was too important to form an instant decision. The paper was ordered to be printed, and a hearty vote of thanks was accorded to the author.

AN order for 20,000 tons of cast iron pipes, required for the main pipe line in connection with the Sydney—New South Wales—water supply, has been placed with Messrs. Macfarlane, Strang, and Co., of 86, Cannon-street, London, and the Lochburn Ironworks, Glasgow. This firm, though the youngest of the Glasgow pipe founders of the first rank, has works, which cover about 14 acres of ground, built in 1878, and capable of turning out 50,000 tons of pipes per annum. The Sydney contract in question represents about £150,000 value, and includes 12,000 tons of pipes 48in. in diameter, 5000 tons of 42in., 1000 tons of 15in., and other sizes, the whole of which have to be completed within 12 months.

MR. CONSUL STANLEY, reporting on the trade and commerce of California, mentions that the product of the precious metals there shows some decrease, which, unless new developments take place, is likely to become more pronounced in consequence of a recent decision in the United States Circuit Courts whereby hydraulic miners are prohibited from allowing the *débris* from their workings to go into the rivers. Rivers have been filled up by such *débris*, necessitating heavy expenses in protecting the valley lands from overflow. During heavy winter rains such protection has often proved insufficient. This decision is of great importance, as, according to Mr. Stanley, it practically puts an end to hydraulic mining save under exceptionally favourable conditions.

ONE more of the blatant denunciations of water supplies as impure has received a quietus. Dr. Campbell Brown has reported on three samples of water from Lake Windermere recently described by Colonel Sandys, chairman of the Kent Board of Conservators, as a "gigantic cesspool." He says, "The proportions of impurities are only increased by a very slight fraction since I examined the water of Windermere nine years ago." In 1875 he pronounced it as amongst the purest water in England. The wording of Dr. Campbell Brown's report is in some parts not so decisive as it should be. If the water is only a slight fraction less pure than when among the purest water in England, it is superfluous to say that it contains no more impurity than many waters supplied for domestic purposes, and absurd to say that it would not be safe to use it for domestic purposes.

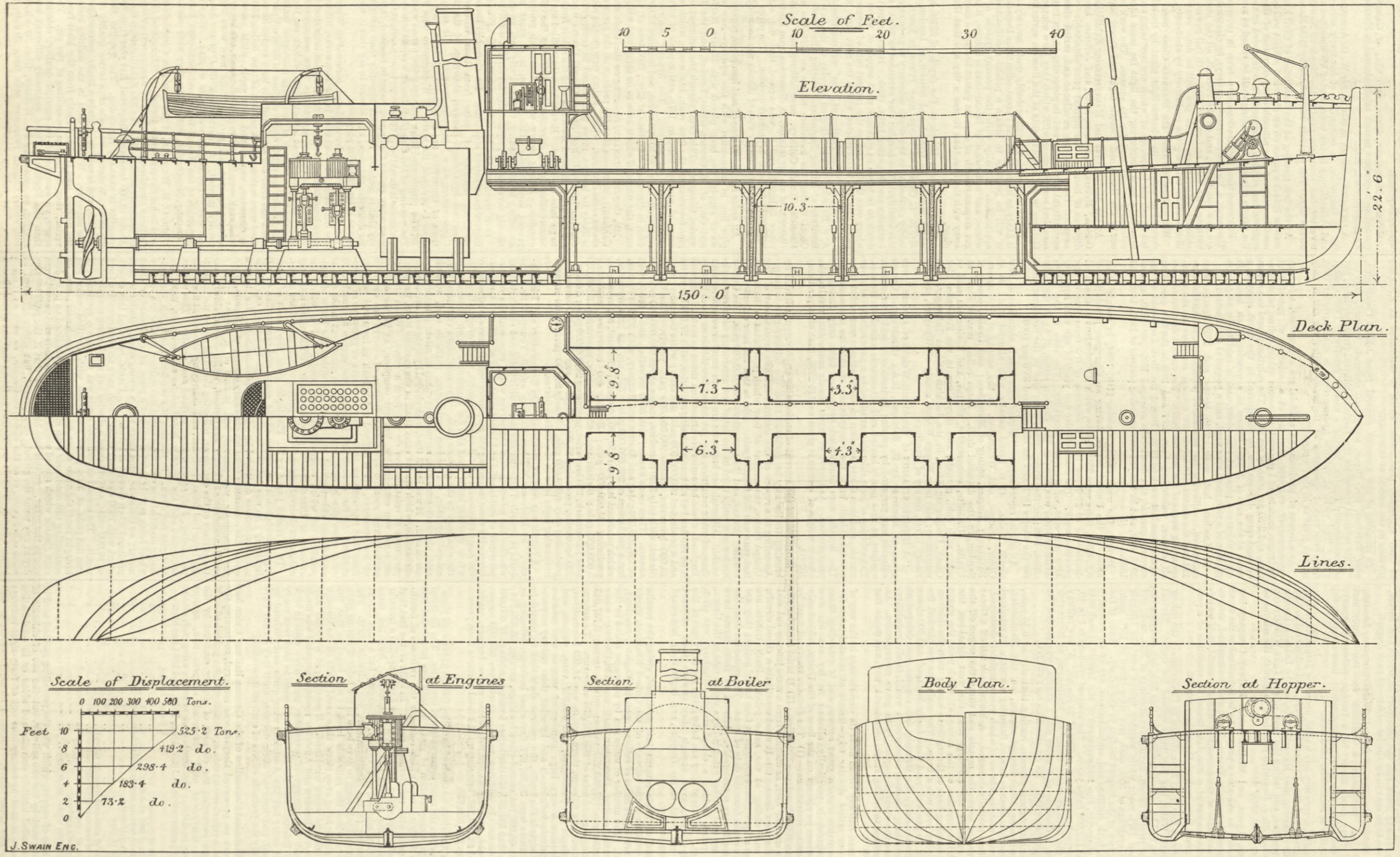
A DISASTROUS boiler explosion occurred on Wednesday night at the Staffordshire Steel and Ingot Ironworks, Bilston. The works have been erected for the manufacture of basic steel by the Thomas-Gilchrist process, and operations were commenced only in June last. It appears that about eight o'clock on Wednesday night three out of a battery of ten large connected boilers which generated steam for thirty-three engines in different parts of the works burst one after the other, and the large engine-houses and the basic shed were scattered. A portion of one boilec, 18ft. long and 6ft. in diameter, was carried fifty yards, while masses of iron and brickwork were hurled to great distances, one heavy piece of metal being projected 400 yards. Three men were killed and about twenty injured. A fourth man died in the hospital yesterday morning. The boilers were new in May. They were under the inspection of the Mutual Boiler and Employers' Liability Insurance Company, Manchester, with whom they were insured for £1000.

MR. C. B. WEBSTER, of the American Consulate at Sheffield, has sent to his Government a report on "Bessemer Steel and Manufactures therefrom," in which he mentions that the large quantity of Bessemer steel sold in the Sheffield district is not all made there. About 10,000 tons were imported last year from Sweden, and the quantity is annually increasing. The Swedish Bessemer, according to Mr. Webster, is made of a better quality of iron than the English, and is said to contain a larger percentage of carbon and less impurity. Wood is used in the melting instead of coal, and the melted iron is run directly from the blast furnace to the converter, thus saving the re-melting of the pig. The Swedish Bessemer, on account of its superior quality, obtains a higher price than the English. There are many different brands, the price ranging, as quoted by Mr. Webster, from 50 dols. to 100 dols. per ton, while English Bessemer sells from 20 dols. to 30 dols. per ton. The sale in Sheffield of each of these brands of Swedish Bessemer is under the exclusive control of some one individual or firm; the right is purchased from a London agent of the Swedish owners.

STEAM HOPPER BARGE, BETA.

DESIGNED BY MR. CLEMENT DUNSCOMBE, M.I.C.E., BUILT BY MESSRS. SIMONS AND CO., RENFREW.

(*For description see page* 350.)

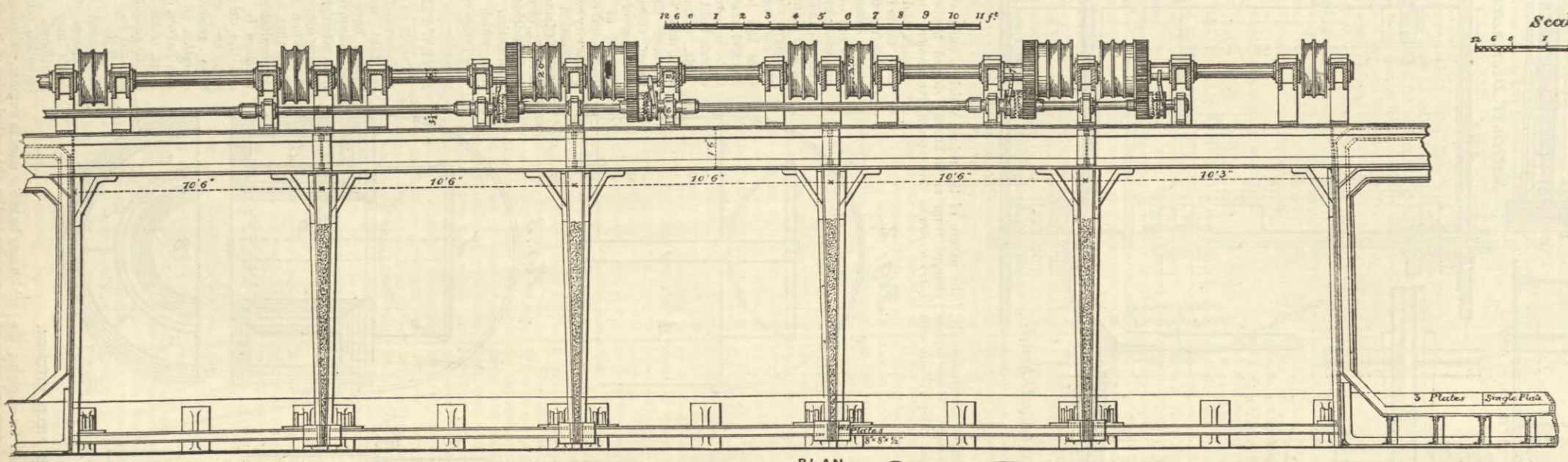


STEAM HOPPER BARGE, BETA.

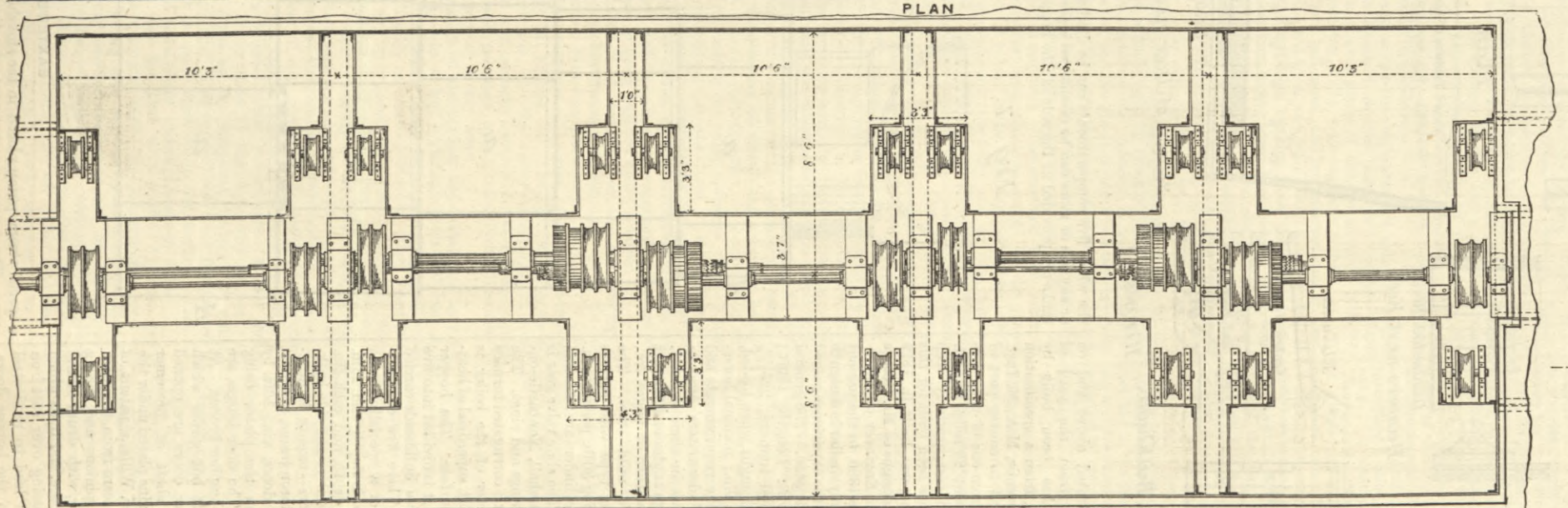
DESIGNED BY MR. CLEMENT DUNSCOMBE, M.I.C.E.; BUILT BY MESSRS. SIMONS AND CO., RENFREW.

(*For description see page 350.*)

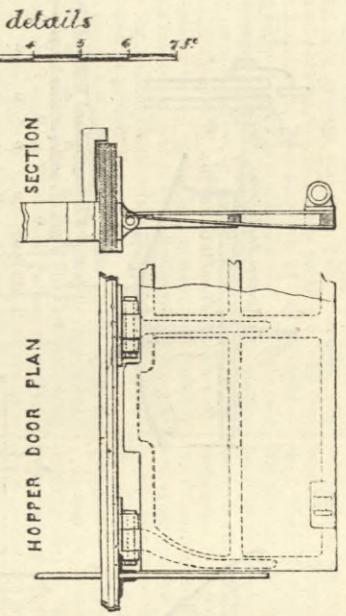
LONGITUDINAL SECTION

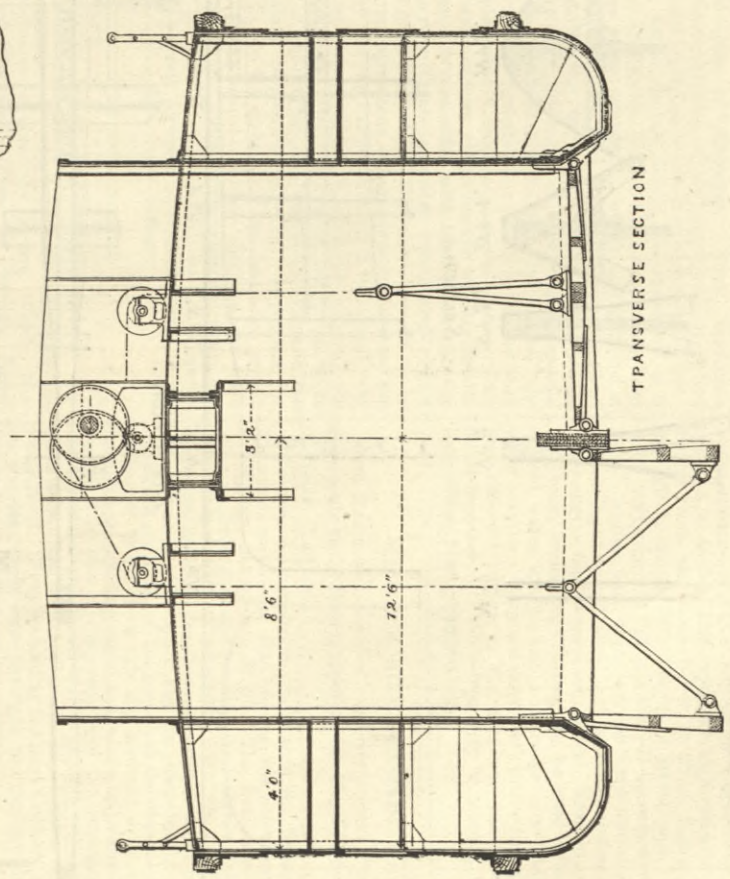


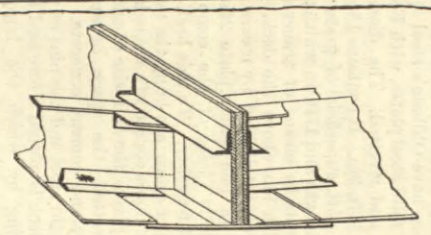
PLAN



Scale for details

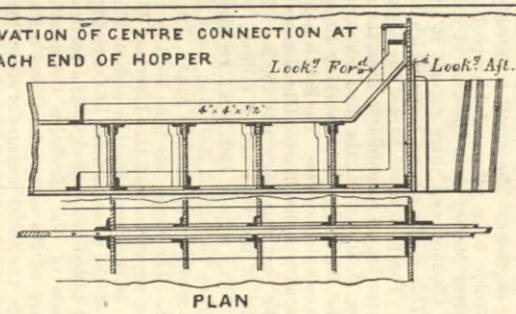




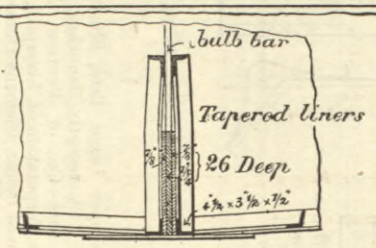


LOOKING AFT.

ELEVATION OF CENTRE CONNECTION AT EACH END OF HOPPER



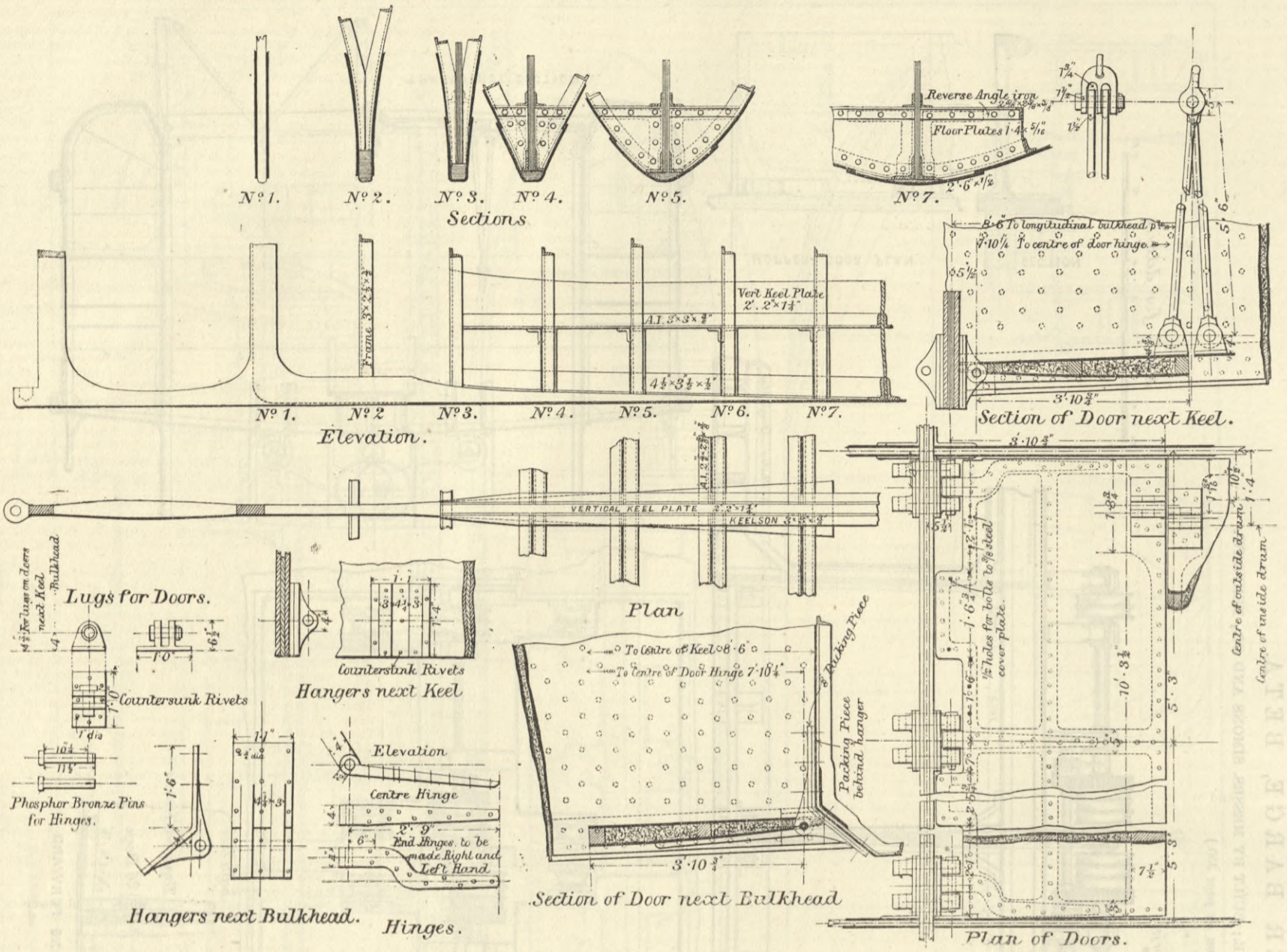
PLAN



LOOKING FORWARD

DETAILS OF STEAM HOPPER BARGE, BETA.

DESIGNED BY MR. CLEMENT DUNSCOMBE, M.I.C.E.; BUILT BY MESSRS. SIMONS AND CO., RENFREW.

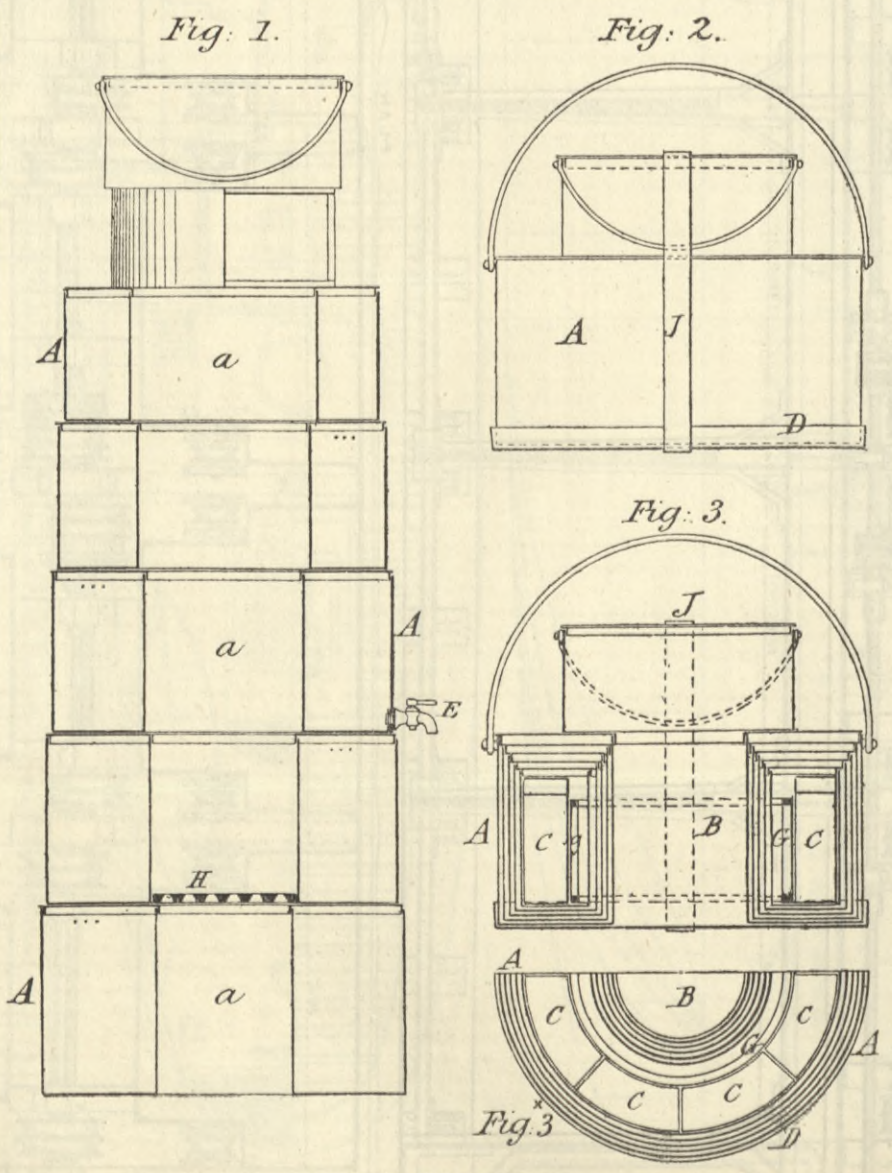


THE steam hopper barge Beta, illustrated above and on pages 348 and 349, recently launched from the yard of Messrs. Simons and Co., of Renfrew, has been built by that firm for the Corporation of Liverpool, from a specification and plans prepared by Mr. Clement Dunscombe, M.A., M. Inst. C.E., city engineer. The vessel is intended to convey part of the unsaleable town refuse of Liverpool from one of the docks on the river Mersey to a distance of about 28 miles into St. George's Channel, and there deposit it in comparatively deep water. This is the second barge which has been built for this purpose. The first vessel, named the Alpha, was built in 1879 by the same firm of shipbuilders, from the designs of Mr. George F. Deacon, M. Inst. C.E., the then Borough Engineer of Liverpool. The Alpha has been working since 1880, to the present date, with complete success. The Beta is mainly similar in design to the Alpha, with such minor modifications as the experience gained during the past four years' working has dictated. The general dimensions of the Beta are as follows, viz.: Length, 150ft.; breadth, 25ft.; depth, 13ft. 6in.; registered tonnage, 225 $\frac{39}{100}$ tons; load to be carried, 350 tons; mean draught when loaded, 9ft. 8in.; mean draught when empty, 7ft. 9in.; nominal horse-power, 88. The vessel has been built to the requirements and under the supervision of the Liverpool Underwriters' Association, and is registered for the highest class in their registry. The hull of the vessel is made of Coatbridge angles and Consett plates, all tested as specified, special parts at turn of bilges, &c., being made of the Blochairn Company's mild steel. The engines are of the compound direct-acting type with surface condensers, the initial pressure of steam being 80lb. per sq. inch. The diameters of the high and low-pressure cylinders are 22in. and 40in. respectively, and the stroke is 30in. The slide valve gear is that invented and patented by Mr. F. C. Marshall, Newcastle-on-Tyne. The pistons have Oldham's steel springs and rings. The boiler is made of mild steel plates, with Fox's corrugated furnace flues, all flanged and rivetted. The diameter of the boiler is 13ft. 3in., length 10ft. 3in. It contains 1350ft. superficial of heating surface, and 45ft. superficial of grate surface. The hopper space is 52ft. in length and 17ft. in width; it is divided into five equal compartments by means of transverse bulkheads carried up to a level of 3ft. 9in. above the deck. These five compartments are further subdivided by means of a specially strong iron keel formed of one centre plate 26in. in depth and 1½in. thick, and two side plates of the same depth, and each ⅞in. thick, all rivetted together. To this keel, and to the side bulkheads of the hopper space, are hung the doors—twenty in number. The hopper doors consist of a wrought iron frame, as shown above, to which plates the full size of the doors, viz., 10ft. by 4ft. 2in., are rivetted, the space between the plates being filled in with Portland cement concrete. The door hinges are made of tough mild steel and the pins of phosphor bronze. At the level of the deck is placed a fore and aft box girder which carries the gearing by which the hopper doors are opened and shut. This consists of a main shaft of Bessemer steel 3½in. in diameter, driven by a deck engine placed under the bridge. The deck engine is three-cylinder, Willans' patent, of 6 nominal horse-power, and supplied with steam from the main boiler. The main shaft is provided with pinions and sliding clutches for throwing it in and out of gear, with drum shafts which extend fore and aft of each hopper space, and upon which spur wheels and drums are keyed; chains passing over cast iron pulleys placed on the transverse bulkheads lead to mild steel links 1½in. thick, which connect them to the hopper doors. The clutches on the main shaft are so arranged that either the whole five compartments can be discharged simultaneously, or any one or more can be discharged separately. Water ballast tanks are provided at the side of the hopper compartment with a special steam pump placed in the stokehole for emptying the same. The hopper compartments are 4in. longer and wider at the bottom than at the top; this is rendered necessary owing to the nature of the refuse, which is such as could not be discharged from an ordinarily shaped hopper. The vessel will carry a crew of one captain, five seamen, one engineer, and two firemen, and due provision has been made for that number in fitting up the forecastle. The engine companion and wheelhouse are of angle iron frames and wrought iron plates. Provision is made on board, for the electric light so as to facilitate loading at night when requisite. The cost of the vessel complete has been £12,000, viz., £11,696 amount of Simons and Co.'s account and £500 for electric light.

Mr. John Brodie, M. Inst. M.E., now Town Surveyor and Harbour Engineer of Whitehaven, superintended the construction of the vessel in his capacity at that time as chief mechanical engineering assistant in the city engineer's office. The specification was prepared by Mr. Clement Dunscombe, M.I.C.E., city engineer, to whom we are indebted for the preceding information and the drawings from which our engraving has been prepared.

A NEW FIELD KITCHEN.

TROOPS on service in the field, engineers and surveyors engaged on field work, tourists, and others, have often experienced the inconvenience resulting from attempts to light fires for cooking operations in the open air. When to the difficulty is added that arising from damp or unsuitable fuel, this inconvenience is largely increased, and the delay fatal to comfort and even health. We have recently inspected in operation an invention by Captain Baxter, of the Royal Engineers, which is both rapid and effective in obviating the obstacles referred to; while its extreme simplicity and portability recommend it for the use of all classes of travellers whose needs may be those above-mentioned. In principle this invention consists of a series—which may be two or more in number, according to requirement—of annular kettles, the central tubes of which, when the kettles are placed one above the other, form a continuous flue or



BAXTER'S FIELD KITCHEN.

chimney, in which the combustion of the wood or other fuel is maintained by the strong induced draught. In a recent experiment witnessed by us, when four of the kettles referred to, containing 13½ gallons of water, were used, boiling commenced ten minutes after the fire was lit, and in twenty-five minutes potatoes were thoroughly cooked. The consumption of ordinary waste wood during this process was but 8 lb., a bright, full fire being maintained throughout, and every particle of the fuel being thoroughly consumed. The strength of the draught—which had to be greatly checked in consequence of the lightness of the fuel used—assured us that any sort of combustible matter would burn freely, enabling cow or camel's dung, dried grass, &c., to be used in the absence of any other more suitable fuel. It is scarcely necessary to say more to demonstrate the utility of Captain Baxter's invention, which we hear has been very successfully tried by the military authorities in competition with the army field kitchen at present in use.

Our illustration shows a series of four kettles placed in readiness for operation, as also the extremely portable appearance they present as packed when out of use. The kettles being made of diminishing sizes, enables them to be packed one within the other, the whole fitting into an outer case which serves as a stand, and ash-pit when the fire is lit. These kitchens are made of several patterns and sizes, suitable not only to the use of travellers and soldiers, but to that of boating and sporting parties, contractors, tricyclists, workhouses, prisons, factories, schools, soup kitchens, and for cooking food for cattle and hounds. The sets include also the useful frying-pan, which can be employed when required above the flue. We have examined the various patterns of Captain Baxter's patent, manufactured by Messrs. Adams and Son, Haymarket, London, who are the sole makers, and they seem to us to be well suited to the use of the different classes of travellers and others for whom they have been designed.

One important advantage besides those above-named, which it appears to us may well be claimed for the invention, is the adaptability of the system for cooking in open boats. A little sand strewed below the flue on the bottom of a boat would sufficiently guard against any accident which the few falling embers might otherwise cause. It may be added that not only are the kettles self-contained when packed, but that they afford space for the storage of plates, mugs, filter, and canister for stores, which is ingeniously availed of by the manufacturers. So extremely portable is the whole arrangement that a field kitchen capable of cooking for seventy men can be carried by a single individual.

DISCOVERY OF THE FOUNDATIONS OF A ROMAN BRIDGE IN THE RIVER TRENT.

In the course of carrying out large dredging and other works for the improvement of the Trent navigation which connects Hull, Grimsby, and Goole by water with Birmingham and the Midland canal system, a most interesting discovery has been made, and one which seems likely to receive more than an ordinary share of attention from antiquarians and historians. On the passing of the Trent Improvement Act last spring, the Navigation Company commenced operations in a reach of the river lying between the villages of Collingham and Cromwell, north of Newark. Near the former of these is supposed to be the Roman station of Crocolana, and the latter is given by Carlyle as the nursery of the Cromwell family. The works in progress include a large amount of dredging, the quantity of material already removed from the river bed amounting to some 50,000 yards, and it was during this operation that the workmen came across what had been formerly mistaken by Trent boatman for a sunken barge or keel, but what proved on further probing and careful examination to be the pier of an old wooden bridge; about 40ft. or so closer to the north bank, another of similar appearance was found, and it is presumed there are six or seven of these piers forming the whole bridge. A decision was come to by Mr. Rofe, Mining Institute, C.E., engineer-in-chief, to blow up the two piers obstructing the navigable channel with dynamite. This was done carefully and effectually under the superintendence of Mr. Whieldon, surveyor to the company, and Mr. Johnson, of Tower-street, Dudley—acting for the Explosives Company, of St. Swithin's-lane, E.C. As this "record of old time" lay in mid-channel 4ft. or 5ft. under water with a strong current running, it was fully expected that holes would have to be drilled into the solid masonry and the shots fired by electricity from the shore. This being a very tedious and expensive method, Mr. Johnson decided to try much easier, but still more risky, means. The dynamite having been made up into waterproof packages of 10 lb. each, the operator, with surveyor and assistants, started in a small boat, guided by ropes from each side of the river, to the scene of action. On arriving immediately over the old foundation, which was found to be diamond shape, a charge was lowered on to the one end. All being ready, the fuse was lighted, and the boat drawn rapidly down the river out of harm's way. Inspection proved that the old obstacle had been hit very hard. Another heavy charge was then placed in the centre, and exploded in a similar way, bursting the whole structure, and throwing up an immense cone of water, the falling spray from which was driven by the wind at least 200 yards away. Eight shots in all were fired, the last of which made a clean job by blowing up the old oak centre baulk and cross-pieces, the whole lot floating down mid-channel like a huge whale. In three hours, eight charges, judiciously disposed, completely wrecked the remains of a work which have withstood the action of weather and water for sixteen centuries or more, and over which many a hard-contested struggle has taken place, as shown by the numerous human sculls and bones which have been dredged up. A portion of wood and stonework was, however, afterwards recovered, and excavations are to be made with a view to finding and preserving another of the remaining piers. From observations previous to blasting, it appeared that the foundations were formed of wood set in Lancaster or a somewhat similar stone; the oak walings and baulks were black and hard, but mostly in good condition; the work was still quite hard and adhesive; the walings were tied across through a large centre baulk by tie pieces of wood having octagonal heads, through which wedges had evidently been driven to keep the structure together. There is room for doubt whether any similar structure of wood now remains in such complete preservation, although in Rome itself some traces of a wooden bridge, supposed to be either the Pons Aetnilius or the Pons Sublicius, have been seen in the Tiber, but they do not appear to have been distinctly recognisable. From Ralue, or Leicester, the ancient Fosse-road makes its way through Vernometum and Margidunum, thence by the Trent banks to Lindum, or Lincoln. Between Margidunum and Lindum two stations are given in the "History" of Antoninus, the sites of which have been a matter of some dispute among the learned. Of these two, Crocolana seems to have taken up its position, by general consent, at Brough, near Collingham; and Ad Pontem, the other, is generally placed at Farndon. At first it would appear that the position of Ad Pontem had been solved by the discovery near Collingham, but the distances given by Antoninus do not there correspond, and the bridge now traced can only be fixed upon as adjacent to the station Ad Pontem by the supposition that Crocolana and Ad Pontem have been accidentally transposed in the Iter of Antonine. Local historians have attempted to fix the position of Ad Pontem at Newark and Southwell. There are really no proofs in existence which go to show that Newark was a Roman station, but Southwell, if it was not actually the Ad Pontem, bears evidences of having been held by the Romans as an advanced post across the Trent in their northward advance. As the Romans were excellent engineers, it is probable they were not particular to a bridge or two across the Trehenta, the banks of which, for commercial and other reasons, would at that time be very populous, and the bridge now discovered was probably a connecting link between the district of Lindum and Crocolana and the station Ultra Trehentam—Ad Pontem or some other—on the way northward.

It may be mentioned in connection with these works for the improvement of the river Trent—a matter which Staffordshire manufacturers take great interest in—that there appears to be some possibility of an agreement being come to between the Navigation Company and the Corporation of Nottingham, who have hitherto strongly and rather ill advisedly opposed the proposals of the company. The Corporation are to subsidise the company, and in return the company is to commute the river tolls on sanitary cargoes, to give the Corporation an *ex officio* representative on the directorate and control of certain flood works within their municipal boundary. Such an agreement would no doubt save a most costly parliamentary struggle, and will be viewed with favour by many interests in the Midlands, which are anxiously looking forward to improvements in our system of inland navigation and water carriage.

VERTICAL TANDEM ENGINE.

We illustrate on page 352 a vertical tandem compound surface condensing engine constructed by Messrs. Worth, Mackenzie, and Co, of Stockton-on-Tees, for Messrs. Foster, Brotherton, and Co., timber merchants, of the same town, to replace an ordinary high-pressure engine, under guarantee that the saving in coal should be at least 50 per cent., and in town's water 90 per cent. The existing engine had a single cylinder 18¼in. diameter by 4ft. stroke, making 36 revolutions per minute, and driving the mill shaft, at 116 revolutions, by spur gearing. The boiler was 6ft. diameter by 24ft. long, with one flue, and worked at 60 lb. pressure.

The compound engine has one high-pressure cylinder 12½in. diameter, the lower flange of which is bolted to a distance piece 9in. deep carried on the top flange of the low-pressure cylinder, which is 20in. diameter. The high-pressure piston has two external rings of hard bell metal, and one internal ring of steel, and is secured to the rod by a nut with a steel pin through the nut; to prevent this nut from working loose there is an octagonal recess ¾in. deep cast in the top side of piston; this recess is about 1in. across larger than the hexagon nut, and is slightly dovetailed and run up with patent metal after the nut has been well tightened up, making a thoroughly secure job. The stroke of both pistons is 18in.; the piston rod is of forged steel, 3in. diameter for the lower cylinder, and 2¼in. diameter for the 12½in. cylinder, and passes through gun-metal bushes in the distance piece, and is made tight by one gland. By this arrangement the piston rod between the cylinders is never exposed to the air, room is saved, and the gland is found to keep tight with very little attention. The crosshead is of cast steel, and is secured to the piston rod by gib and cottar, so arranged that by reversing the position of the same the rod can be forced out of the crosshead when required. The crosshead shoe bears on a motion bar of hard cast iron, which is secured to the planed face of the column by turned bolts. The cylinders are carried on two wrought iron pillars at the front and on one cast iron column at the back. The condenser is usually cast in one with this column, but in this engine, as there was a possibility of damage through frost when the mill is idle at Christmas holidays, it has been considered better to make the condenser independent and of wrought iron. The condenser is 2ft. diameter by 2ft. 6in. long, and contains 162 tubes of brass; the total surface is 84 square feet, and the vacuum varies from 12½ lb. to 13½ lb.

There is one pump 6in. diameter by 18in. stroke, the bottom end of which is the air pump and the top end the circulating pump; it is lined with gun-metal, and has gun-metal bucket and rubber valves on brass grids. There is an air valve fitted on the cover between the valves of the circulating pump, by means of which the quantity of circulating water can be regulated, and which has the further effect, in combination with large air vessels, of keeping the pump noiseless. The air pump delivers to a hot well situate at the front of the engine, from which the feed pump, 2½in. diameter by 3in. stroke, drains its supply. The pump is driven by an excentric cast in one with the valve excentric, and there is an arrangement in the hot well to prevent any grease being pumped into the boiler.

The connecting-rod is of wrought iron, and the bearings in the same are of phosphor-bronze, and 2½in. diameter by 4in. long for the small end and 3¼in. diameter by 5½in. long at the crank ends. The disc is of cast iron with a steel pin, and has a wrought iron hoop 4in. by 1in. shrunk on. The excentric sheaves and straps are of cast iron, and the valve excentric is 4in. broad; the excentric rod is of wrought iron, and the double-eye is made unusually large, and provided with a brass block adjustable by wedge and nuts to take up any wear.

The slide valves are of the hardest bell-metal, and have 4in. travel; the lap is $1\frac{5}{16}$in. at top, $1\frac{7}{16}$in. at bottom, and lead $\frac{5}{32}$in. at top and ⅛in. at bottom. The governors are of the high-speed type, and work directly on the equilibrium valve without the intervention of any levers, and are able to control the engine under the most sudden changes in the load.

This engine is coupled directly to the mill shafting, and is driven at 118 revolutions per minute by the same boiler and at the same pressure, and the results of twelve months' working are as follows:—Value of coal consumed by high-pressure engine 18½in. cylinder, 4ft. stroke, £99 1s. 8d.; ditto by compound 12½in. and 20in. cylinder, 18in. stroke, £34 7s. 9d.; saving, £64 13s. 11d. Water used by the high-pressure per week, 14,000 gallons; ditto by the compound under, 1000 gallons; saving, 13,000 gallons. The water of the river Tees is used for condensing, but is quite unfit for boiler feeding. The 1000 gallons named of town water is used to make up waste.

This engine was intended to develope 85-horse power, but there has as yet been no opportunity of indicating it with a full load on. We therefore publish diagrams taken from another similar engine, the dimensions of which are as follows:—Diameter of high-pressure cylinder, 12½in.; diameter of low-pressure cylinder, 22in.; stroke of both, 18in.; revolutions per minute, 120; air pump diameter, 7in.; stroke, 18in.; condenser surface, 116 square feet. The dimensions of the cylinders for these engines were worked out in accordance with the rules given in The Engineer of October 17th, 1879, and the latter engine was intended to indicate 100-horse power, with 70 lb. initial pressure, and it will be seen from the diagrams that the actual result works out very closely in accordance with the rule, indicated power being 102·8, with initial pressure of 68 lb. and 69 lb. respectively. This engine replaced a double 12in. cylinder high-pressure engine, and is driven from the same boiler at 20 lb. higher pressure, but through a considerable length of steam pipe. Steam can be easily maintained to indicate the 100-horse power with the compound engine, but could not be kept up to drive the non-condensing at more than 50, and the consumption of fuel with the latter engine was 50 per cent. more. Engines of this description, being surface-condensing, can be used wherever a supply of cold water can be had, no matter how dirty or salt that water may be. They are safer and require less attention than a high-pressure engine, as the feed will take care of itself for hours together, and the boilers may be worked three times as long without being cleaned out.

THE HEALTH EXHIBITION.

The Executive Council of the International Health Exhibition have made the following report to his Royal Highness the Prince of Wales, President:—

We have the honour to report that the International Health Exhibition was closed this evening, the attendance on this, the closing day, having been 37,168. The Exhibition has been open 151 days, being five days less than the Fisheries Exhibition in 1883. The fact that 4,167,683 admissions have been registered during the hours this Exhibition has been open incontestably proves the public approval of its objects, and also demonstrates the great value, for exhibition purposes, of the ground at the disposal of the Commissioners of 1851. Even this site, however, extensive as it is, was found in practice very restricted for the full accommodation of the recent Exhibition and the comfort of the numerous visitors. The close attention given to the various exhibits, together with universal good order, has been a characteristic feature of the Exhibition throughout. Notwithstanding the large numbers, as high as 71,884 in one day, which have thronged the gardens and buildings, no injury has been done, no loss sustained.

The Exhibition has comprised the exhibits of 2109 exhibitors, supplemented by the Chinese Exhibition, and the collections forwarded by the Japanese and Siamese Governments, and also by some exhibits which we deemed it proper to form, or to assist in forming, as being beyond the scope of ordinary exhibitors. Such were—(1) The historical series of dress exhibits. (2) The display of the power of electric light for external and internal lighting, as also for ornamental display. (3) The Tartar mares from Orenburg, and the preparation of Koumiss on the spot. (4) The sanitary and insanitary houses, also as having a special scientific educational value. (5) The hygienic laboratories, biological and physical. (6) The formation of a library of sanitary works and papers. Of these it is hoped by many persons that the library and the laboratories may have more than an ephemeral existence.

The library, containing already a valuable collection of publications and Government papers on sanitary matters from all parts of the world, would—if made accessible free of charge throughout the year to the many who take an interest in sanitary questions, and supplied with the various publications and papers from time to time issued on such matters—doubtless be of very great utility. It would enable those interested readily to ascertain recorded facts, and thus remove misapprehension on matters of vital import to the well being of the nation.

The maintenance of the laboratories would ensure a means of sanitary research and teaching for the future which England has not had in the past. In these laboratories studies could be carried on and teaching could be given of a kind similar to that which is afforded by various foreign institutions which have been established in the interests of the public health. These studies have a direct bearing on the solution of health problems which not only affect the well being of communities, but exercise an important influence on agricultural and commercial interests. With your Royal Highness's permission, we would propose to consider further these matters, and perhaps make suggestions for your Royal Highness's consideration.

The educational division of the Exhibition, mainly displayed in the City Guilds Institute, contained a very good representation of the most important educational movements, and deserved the close study given to it by those specially interested in education. It would be impossible to enter into details about the various elements of this Exhibition; but the gymnastic exercises for boys and girls, conducted under the guidance of the educational division of the Exhibition, met with approval from the public and from educational authorities.

In order to make this undertaking as useful as possible for advancing knowledge, arrangements were made for holding a series of conferences, and for the delivery of lectures on subjects connected with public health and education. These conferences were conducted under the superintendence of various societies. They dealt with many subjects of public interest; and it is believed that much useful information was thereby diffused, and that in some instances practical results of value to the public health may be expected. We have the honour to transmit a complete set of the literature of the health branch of the Exhibition, comprising, in volumn form, twenty-eight handbooks and the reports of fourteen conferences and thirty-eight lectures. Those connected with the educational branch will accompany our further report.

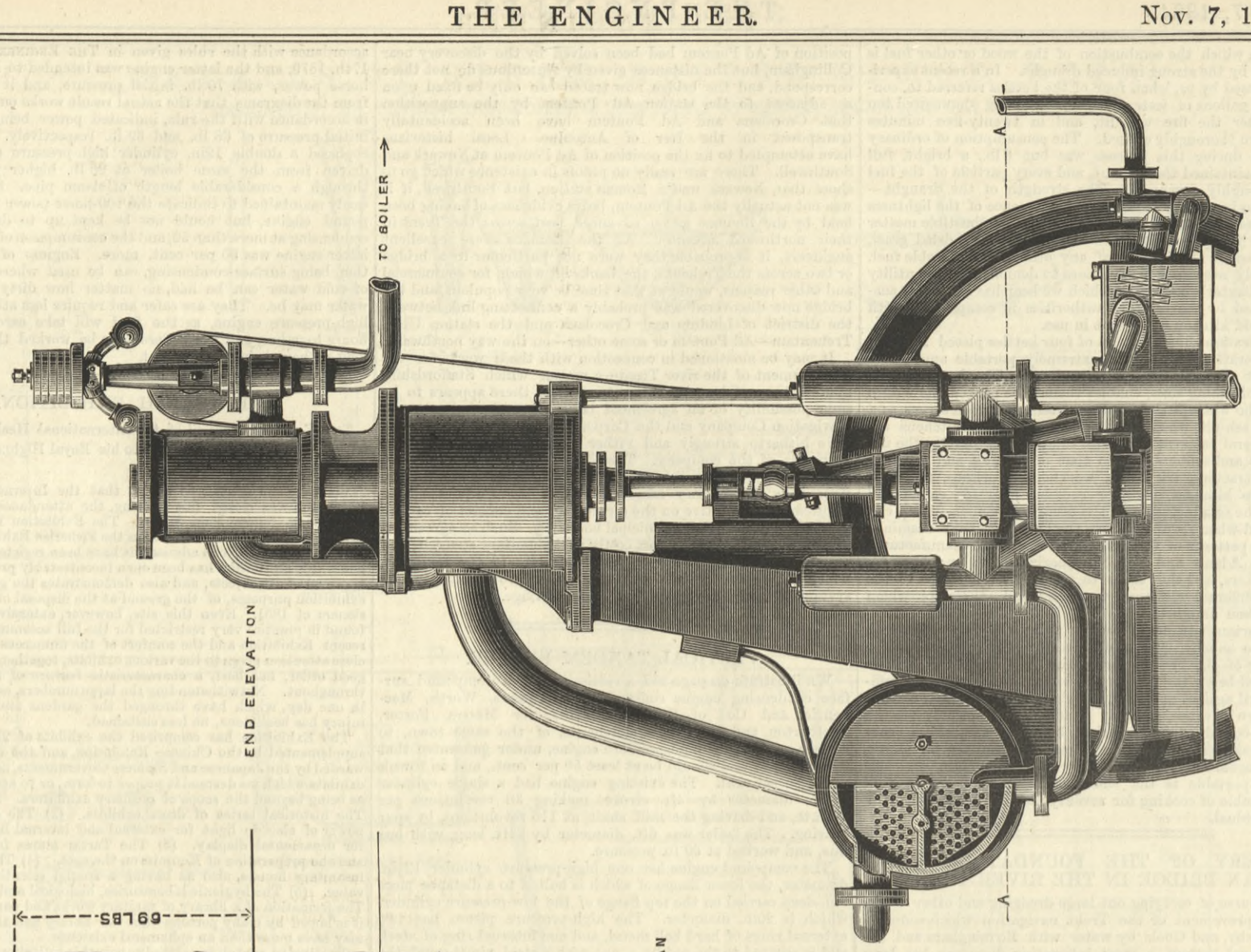
The expenses of the Exhibition, both in its organisation and maintenance, have been heavy. The magnitude of the work which was done will be fully demonstrated in our final report, which we shall shortly make; but we are already enabled to state that no call will have to be made upon the guarantors, and that we shall be in a position to return the several deeds of guarantee.

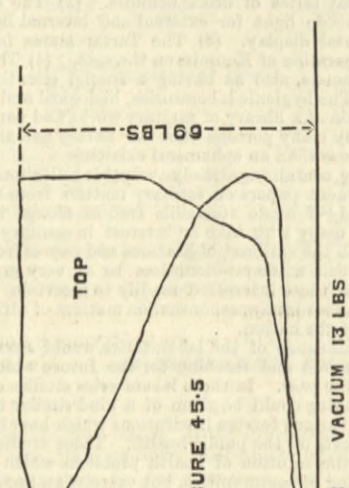
Society of Engineers.—At a meeting of the Society of Engineers held on Monday evening, November 3rd, 1884, at the Westminster Town Hall, Mr. Perry F. Nursey, vice-president, in the chair, a paper was read by Professor Wanklyn on "The Cooper Coal-liming Process." The author commenced by citing a number of analyses of coal, and after entering upon several details he arrived at the conclusion that the coal used in gasworks contained about 1 per cent. of sulphur. He then went on to state that when gas was made part of this sulphur entered into the gas. To rid the gas of the sulphur cost 8d. or 10d. in labour and material, and 8d. or 10d. in interest on plant per ton of coal carbonised, and entailed upon the gasworks the creation of one of the worst nuisances in the whole range of manufacturing industry. Cooper's coal-liming process remedied this state of things, and enabled a gasworks to produce pure gas without creating a nuisance, and with considerable advantage. The author then explained the Cooper process, which consists in the addition of about ½ cwt. of quicklime to every ton of coal carbonised. The lime is slaked with its own weight of water, and is mixed with the coal when being charged into the retorts. The exact *modus operandi* of the oxide purifier was described, and an indirect result of coal-liming mentioned. When the coal-liming process is in full operation, as at the Tunbridge Wells Gasworks, the oxide purifier is transformed into a dry scrubber, the function of which is to bring about a combination between traces of oxygen and traces of sulphuretted hydrogen existing in the gas on its entrance into the oxide purifier. Coal-liming, Professor Wanklyn stated, was singularly free from drawbacks of any kind. The cost of the lime was more than repaid by the extra ammonia. The coke was increased and improved, and the furnace was not injured.

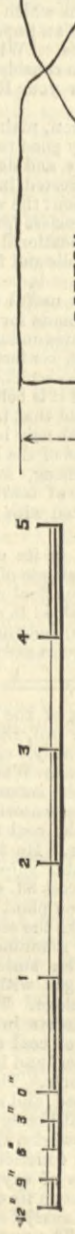
VERTICAL TANDEM COMPOUND CONDENSING ENGINE.

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

(For description see page 351.)







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*** *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.*

Constant Reader.—*W. F. Stanley, Great Turnstile, Holborn, London, W.C.*

W. T.—*There is no other difference. Some makers like crossed rods, others do not.*

W. H. S. and Son.—*We do not know of the existence of any newspaper of the kind in Canada.*

W. M. S.—(1) *J. Kirkaldy, West India Dock-road, E., and most marine boiler-makers. Consult our advertising columns.* (2) *The Analyst—Ballière, Tindall and Cox,* 20, *King William-street, Strand.*

J. R. C. (Blairgowrie)—*If you address a note to the head of the department South Kensington, he will tell you. Binns' "Treatise on Drawing" has been a favourite work with South Kensington students.*

P. H.—*The number of specifications has increased so enormously under the new law that it would be impossible to publish abstracts in the way you suggest; besides, the Patent-office proposes to publish a complete illustrated weekly set of abstracts.*

S. L. (Portsea).—*The boiler must be worked under the same conditions as a marine boiler—that is to say, a scale of lime must be maintained on all wetted surfaces within it. If the steam is condensed on a copper surface, and the iron of the boiler is clean, then corrosion is sure to set in. As it is more than likely, however, that the boiler is pretty well furred, no danger is to be apprehended, save that the scale will be loosened and removed by the condensed water. This may be avoided by adding small quantities of hard water now and then to the feed. The experiment should be tried with caution by a careful man.*

FLUE TERMINALS.

(To the Editor of The Engineer.)

Sir,—Can any reader tell me where Billing's patent flue terminals are now to be procured? Highlander.

November 1st.

HERTFORD WATERWORKS.

(To the Editor of The Engineer.)

Sir,—We notice that by an error this work is described as having been executed in 1883, whereas it was last July. We might take this opportunity of adding that this tube well is quite equal to supplying a set of pumps of four times the capacity of the pumps at present drawing from it. Le Grand and Sutcliff.

Magdala Works, 100, Bunhill-row, London, E.C.,
October 30th.

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

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

MEETINGS NEXT WEEK.

The Institution of Civil Engineers.—Tuesday, Nov. 11th, at 8 p.m.: First ordinary meeting. Paper to be read with a view to discussion, "Electric Lighting for Steamships," by Mr. A. Jamieson, Assoc. M. Inst. C.E., F.R.S.E.

Cleveland Institution of Engineers. — Monday, Nov. 10th, at 7.30 p.m.: (1) List of elections since last meeting. (2) Annual report and balance-sheet. (3) Inaugural address by the President, Mr. Alfred C. Hill.

Society of Telegraph Engineers and Electricians.—Thursday, Nov. 13th, the following papers will be read:—(1) "On the Theory of Alternating Currents, particularly in reference to two Alternate Current Machines Connected to the Same Circuit," by J. Hopkinson, F.R.S., Member. (2) "An Account of Experiments with Alternate Current Machines," by Professor W. Grylls Adams, F.R.S., President.

THE ENGINEER.

NOVEMBER 7, 1884.

SHIPBUILDING IN THE ROYAL DOCKYARDS.

We recently dealt briefly with the building of men-of-war in private dockyards. Attention is now being turned to the system of construction adopted in the Royal Dockyards such as Pembroke, and it will not be out of place if we direct notice to certain facts and conditions controlling, as we believe prejudicially, the operations of the Government as shipbuilders. The system now in force is in many respects a relic of the past. It was well understood that wooden ships should be built under cover in well-ventilated sheds, and as slowly as possible. Accordingly, a great many ships were put on the stocks at one time, and work was done tediously on them. Thus our old line-of-battle ships were some years under construction. Their timbers became thoroughly seasoned before launching; and time was allowed for the development of latent defects; so that if at the end of three or four years a timber or a knee was found to show symptoms of dry rot, it was at once removed. Even in time of war, ships were built as slowly as might be. The traditions of the timber age have been perpetuated in the iron age. Ships are laid down in considerable numbers, and a little is done now and a little again, just as though iron became seasoned and improved after being worked into a hull. Furthermore, the sums voted for the construction of ships in any one year are small. But no First Lord of the Admiralty likes to go to the House with the Naval Estimates unless he has something imposing to put before his hearers. If his Government is accused of neglecting the best interests of the nation, he triumphantly produces figures which show that so far from this being the case, there are a dozen first-class ironclads and a swarm of smaller craft being built. Parliament is pleased and votes the money asked for, quite overlooking the fact that the same ships have done duty in the same way for years and years. They may have even done a good turn to Government after Government. It may, of course, be said that there must be an end to this, and the ships will be launched at last. This is true; but if a dozen ships are launched in one year, each of which has been six years under construction, the whole twelve only represent two vessels a year; while very simple manipulation has made the country believe that it is getting twelve ships a year. Of course, if the statements of First Lords were sifted, the truth would be discovered; but such statements never are sifted. Questions are asked for party purposes, and by the Opposition, and the party in power naturally brushes them aside, and so reform becomes impossible. We are always going to have a splendid Navy. First Lord after First Lord has told us as much. But we never have it.

One of the direct results of the slow progress of construction is that the ships when completed are to a great extent compromise ships. They are the subjects of perpetual alterations, and, we may say, expense. When a vessel like the Agamemnon is nine years under construction, it is unreasonable to suppose that she is very like what she was intended to be at the outset. It is urged that this is not a defect in the system, but an advantage. No reasoning can be more erroneous. Let us suppose that an ironclad can be built in three years. About this there seems to be no doubt at all among private shipbuilders. In nine years, then, three ships could be turned out, each, we may perhaps admit, an improvement on its predecessor. At the end of the first three years we would have one good ship added to the Navy; at the end of the second three years we would have two ships, and at the end of nine years three ships. On the Government system we have to wait nine years, and then we get three ships, every one of which is a compromise. They have all been altered more or less, and we have no difficulty in seeing that the price of these ships, thus built and unbuilt, and altered and patched, must be very greatly in excess of the cost of three ships built straight away from the original designs. It would be difficult to make anyone outside a Royal shipyard believe the extent to which alterations are made and waste of material and money incurred. A volume might be written on the subject. What would the builder of a merchant steamer say if, after the hull was completed and decked, the position of every hatchway had to be changed, and the hull had new beams and frames put in to render it stronger than it was before, in order to carry deck loads for which no provision was originally made? To make such changes, the result of an afterthought, is to nearly double original cost, while the work must of necessity be to a large extent imperfectly done.

Recently we have said a good deal about protected cruisers built in private yards. Such a vessel as the Esmeralda is a long way in advance of any cruiser built by our Government; but it is not in unarmoured cruisers alone that merit is to be found. Mr. Samuda has contrived in the Riachuelo to combine conditions which before she was designed were pronounced to be impossible of attainment in a single ship. This Brazilian ironclad has tremendous gun power, thick armour, and great speed; she is the fastest ironclad afloat, and has enormous distance steaming capacity. When she was described last April at the meeting of the Institution of Naval Architects criticism was silenced, and she was publicly admitted by naval architects, admirals, captains, and engineers alike, to be a splendid vessel—a ship that any nation might rejoice to include in its fleet. The Riachuelo has a displacement of about 6000 tons. She has an armour belt, steel faced, 250ft. long, 11in. thick, in the wake of the boilers, engines, and magazines, 10in. thick elsewhere above water, and from 4in. to 7in. thick below water. She has two 10in. turrets, each mounting two 20-ton steel breech-loaders, equal to piercing 18in. armour. The turrets are further protected by two 10in. breastworks. She can steam at 16·25 knots, and can run 4000 miles at 15 knots without re-coaling. Sir E. J. Reed, speaking of this ship, after referring to the part taken in designing her by himself, Mr. Barnaby, Admiral Azevedo, and Mr. Cavalho, said, "Not only has Mr. Samuda and his very able staff put a very great deal of scientific skill into the construction of this vessel, but they have also displayed an immense amount of courage in order to undertake its construction in all the conditions imposed." Mr. White called her "a triumph," and the most powerful, swift, and best armoured second-class ironclad afloat. The Riachuelo was built in less than three years, and her cost was probably one-half that of any vessel we possess which would dare to fight her. Few or no alterations were made in her. Her design was carefully elaborated, a rigid specification was prepared, and both were adhered to. "You see," said a docykard official to us on one occasion, "there is such a lot of messing about with our ironclads, they are bound to cost a lot. You may have one gang at work constructing, and another gang pulling to pieces at the same time. How can we get on fast? I only wonder some ships ever get finished at all." In the case of the Riachuelo there was no "messing about." We see what the result has been.

It is argued, and with some force, that the highest available talent is employed at Whitehall in designing English ships of war. We have no desire to dispute this. But the talent is not permitted to have quite its own way. There are red tape and tradition. All Government departments tend to develope grooves, and the groove may degenerate into a rut. Thus if it comes to be understood that an ironclad must be big and enormously expensive if she is to be serviceable, no encouragement will be given to any one who attempts to say, like Sir E. J. Reed, that she need be neither big nor costly. Again, there is no conceivable stimulus to get out of the groove. If the Riachuelo had been designed at Whitehall and built at Pembroke, not a soul concerned in the design and construction of the ship would have been one penny the better of it. If Mr. Barnaby could design a disastrously bad ironclad—which we do not believe—he would be none the worse for designing her and building her. There is no reason on earth why better and better ships should be designed year after year by Government officials. But the case is wholly different with the private builder. When a foreign government comes to this country and stipulates for a ship to fulfil certain conditions, it is immensely to the advantage of the builder to make her as good as she can be. The success of a venture of this kind means fame and fortune to the builder. It means that his yard will be busy when the yards of his rivals are empty. It means that he can in the future fix a price certain to pay a good profit. We do not wish to be personal, but we cannot avoid using names. Let our readers contrast the position, as naval constructors, of Mr. Barnaby, working on a fixed salary as a Government official, and Mr. Samuda, working for himself, and ask themselves, other things being equal, which is the more likely to turn out a perfect man-of-war? Which is the more likely to complete that man-of-war with despatch? There can be but one answer. Government service is not, never was, and never can be the best stimulus for the display of talent. A conscientious man will do his duty, and more; but experience shows that conscientiousness left to itself means mediocrity, and this, through no fault of the Government official. He does what he thinks to be his best; but it is not that of which, under more favourable conditions, he would be capable. Stimulus is wanting. The result is that talent does not always rest content to serve Governments. Sir E. J. Reed left the Admiralty. Mr. White has followed suit. Nor is this migration of talent confined to Whitehall. Woolwich knows what it means full well.

To sum up, we wish to repeat that more is to be expected in the way of developing our naval strength by recourse to private firms than by adhering to the existing system. We believe that what is found to work well by foreign Governments is worth trying by our own. We want ironclads. Why should not certain stipulations be laid down, and private firms be invited to tender for the construction of, say, a couple of second-class—as far as dimensions are concerned—armoured ships; the designs *not* to be prepared at Whitehall? With such an example as the Riachuelo before us, to say nothing of ironclads built by other firms than that of which Mr. Samuda is the head, it would be foolish to assert that there is not enough private talent, and skill, and plant in the country to turn out a satisfactory ship. The cost of the experiment would be very small, and we are unable to see how it could be otherwise than perfectly successful, which is much more than can be said of all the ships constructed in Government dockyards. We seldom hear of one indeed which does not require alteration after she has been in commission; and some of the mistakes made seem to be of the nature of great blunders. We need not go far for an illustration. The Agamemnon has been years and years under construction. It is found now that she is put in commission that she will not steer. Sir John Hay asked in the House on Monday night some questions about her. In reply, Sir T. Brassey said that the steering of the Agamemnon up to nine knots is satisfactory. "At higher speeds it is found difficult to steer an accurate course without the assistance of her screws. The turning powers are good at all speeds. Similar cases have occurred in other ships, but have been overcome with better acquaintance with the ships. It is not proposed to make any alteration now, but if on arrival at Malta the difficulty has not been overcome, orders will be given to increase the upper part of the rudder, which may take about a fortnight, at an expense of, perhaps, about £200 or £300. The case of the Ajax is similar." That is to say, that she can only be kept straight by running the port and starboard screws faster and slower, as she yaws right or left, a system obviously not conducive to speed. That the enlargement of the rudder will do much good we take leave to doubt, if, as is stated, the bad steering is due not to want of rudder area, but to the form of the stern.

THE TOWER BRIDGE.

We illustrated last week the two designs presented by the City architect to the Common Council on 29th October, at a special meeting called for the purpose at the Guildhall, and one of which designs—a bascule bridge—was unanimously adopted as the basis for a Bill in Parliament to be promoted during the coming session. We hail with satisfaction this unprecedented unanimity so far as it betokens another forward step towards a much-needed work; but if it be seriously intended to proceed on the lines indicated in the architect's report, our satisfaction goes no farther, and we fear that one more failure is to be added to the many that have become associated with the scheme of a Thames crossing below London Bridge. As this matter has now been so long before the public, and has at intervals been the subject of parliamentary investigation for the last ten years, and as it bids fair to be settled very soon, we shall probably have to recur again and again to what will be one of the most important public works of the metropolis. For the convenience of our readers, we will recapitulate the various

stages in the progress of the scheme up to the present time. In the year 1866 the report upon the City traffic by Mr. W. Haywood, the engineer to the Commissioners of Sewers, brought prominently into view the growing need for East End communications, and among the improvements suggested was that of a bridge at or near the Tower. But although this was even at that date an old question, Mr. Haywood was far ahead of his employers; anything that might hinder, however slightly, access to the wharfs of Lower Thames-street was abhorrent to their minds; and the councillors for the Billingsgate Ward enlisted the ready sympathy of the great majority of their colleagues in silencing even the suggestions of a bridge. The want of communication pressed hardly on the Eastern parishes as well as on the City itself, but their grievances found no articulate expression, for the Board had other work in hand, and even if they had cared—which they did not—they would hardly have ventured to promote a bridge scheme in the face of the City opposition. The loss and inconvenience arising from the convergence of traffic to London Bridge continued to increase, and in 1875 two letters in the *Times* from Mr. Haywood and from Mr. R. M. Ordish again excited public attention by showing that the only solution of the traffic difficulty lay in the construction of a bridge. At this time, however, the question was broadened, for railway as well as road communication was discussed. To any one who considers the growth of railway traffic north and south of London, it is obvious that no convenient opportunity for crossing the river should be neglected, and it can only be a question of a few years before the demand for increased facilities will compel attention. The utilisation of the Thames Tunnel by the East London Railway has only postponed the difficulty which will crop up at intervals, ever becoming shorter till set at rest by the construction of a railway bridge.

In 1876-7 the pressure of public opinion had at last some effect, and the Metropolitan Board of Works took steps to obtain the necessary powers for the construction of a bridge. But no person in authority dared propose a proper low-level bridge against the powerful interests of the City. The Thames Conservators declared that mechanical openings in such a bridge would impede navigation; and the ill-judged compromise of a high-level bridge was selected as the scheme on which to seek parliamentary powers. This plan was doomed to failure from the first. The wharfingers in Thames-street asserted that even the proposed headway of 65ft. was insufficient for masted ships, but their opposition was unnecessary, for a parliamentary committee wisely decided that to drag the traffic of a city up to the proposed high level, involving a climb 35ft. higher than on London Bridge, could not be entertained, and threw out the Bill. Again the matter rested, for the wharfingers shadowed forth such immense claims for compensation if sea-going vessels were shut out—the whisper of millions sterling was so ominous—that the complaints of Eastern London and the obvious remedy again were unheeded, and neither in Spring-gardens nor at Guildhall would anyone venture on a low-level bridge. The comedy was, however, not yet played out, for in 1883 the Metropolitan Board of Works gravely proposed a tunnel, and brought evidence to show that the gradients and the lifting of traffic, which had been found prohibitory in the high-level, would be suitable and appropriate if reversed and arranged in a subterranean passage. Again the game went on, counsel and engineers received their fees, the ratepayers were mulcted of more money, and the scheme was, of course, rejected. But, in rejecting the Bill, the committee added a recommendation that a low-level bridge, with mechanical openings, be constructed, and, with an astute appreciation of the real difficulty in the way, added that the Corporation, and not the Metropolitan Board of Works, be the authority to execute the work. This timely concession to the dignity of the City, that they, and not their West-end rivals, should have the handling of the scheme, has been successful. A committee was appointed to prepare a design, and this has resulted in the unanimous adoption of the one already referred to. It has become evident that the City opposition is no longer to be feared, for the majority of the Council have discovered that in supporting the extreme views of those more immediately interested in obstruction, they were imperilling the much greater interests of their body, already under the shadow of a coming Municipal Reform Bill.

With every respect for Mr. Horace Jones, the genial and popular City architect, we are bound to say that he is hardly the man to design the bridge, although he may protect the interests of the Corporation in determining on a design. If we may be allowed to say so, there is too much architecture and too little engineering in his scheme. Without in any way pinning him to what he frankly described as a preliminary sketch, we do not think that the maker of such a sketch can have a right conception of the work in hand. The shape and position of the curved chains, the combination of such chains and bracing with a lattice or trussed girder, are all ideas long ago exploded as an erroneous system of construction. Further, the placing of two solid piers, each 40ft. wide, in the middle of the tide-way, although it may be necessary to the towers and system of bascule proposed, are not essential to a bascule opening of the same width, and will cause much difficulty and expense when, as assuredly will happen, they come to be removed.

It is to be hoped that the Corporation will take full advantage of the present opportunity to give London a bridge worthy of the site, the purpose, and themselves. To those of our readers who may be unacquainted with the mysteries of City government, and who may wonder why this scheme has been entrusted to the City architect, instead of to the City engineer, we may say that there is no such latter functionary, and that Mr. W. Haywood, who is so well known in connection with City improvements, is the engineer of the Commissioners of Sewers; and though he has also the control of the streets, and has in that capacity expressed sound views in the past on the Tower Bridge question, he is apparently not the official to whom the designing of a bridge can in usual course be entrusted. It is necessary to speak plainly, and if the Corporation merely intend to leave the design of the bridge to the City architect, with such assistance as he may choose to obtain outside his office, then the chance of a bridge being authorised by Parliament and speedily built is indeed a small one. There are still those in the City who would not object to such a result. We should prefer to believe that the design put forward is not only as the architect stated, a hurriedly-prepared sketch, but that it is one which may be entirely superseded. Much of the failure of the Metropolitan Board of Works was due to the circumstance that they also kept the designing of their various schemes to their own officials, who, while they probably took other professional aid, did so only from their own friends. In no other capital in Europe would such a course be followed or permitted. The notable bridges which have been constructed over the great rivers of the world were not so designed.

The pilgrimage to Holland and elsewhere, which the committee of the Corporation made for the purpose of inspecting bridges with mechanical openings, while interesting and useful, as proving to them that such structures were practicable was of no other value. The members of the Common Council do not, of course, themselves pretend to technical knowledge, although there are able architects among them, but they ought also to understand that in no branch of engineering do circumstances alter cases more than in bridge building; and that the conditions of site and purpose are never twice alike, and ought to be fully studied by many minds to arrive at the best result. In some way or other the skill of the best bridge designers of Europe ought to be enlisted, and their ideas elicited. For the preliminary work in Parliament, as demanded by the standing orders, and which must be done immediately, no design is necessary. If the exact site be determined, the width, levels, and headway of the structure shown on the deposited plans, and the property affected by the approaches scheduled, then the bridge itself, if kept within these lines and within the recommendation of last year's Parliamentary Committee, may be discussed without undue hurry and after careful investigation. During the last few years various schemes have been put forward for the Tower Bridge, but they have been those of amateurs or other irresponsible persons, who have either propounded schemes as novel, which, with hardly an exception, are of ancient date; or else schemes which involved tolls or other source of revenue to their promoters. No capable and well-known bridge designers have troubled themselves, for the good reason that they have never been asked, and because, not only were the conditions unknown, but also because they had no guarantee that either credit or remuneration would be given for a good design. If, as appears likely, a million sterling is to be spent on the structure and the expenses connected with it, surely it is worth while to spend a few thousands in getting ideas. Let plans and sections of the site and approaches be prepared, and conditions as to gradients, waterway, and headway be established, and then let the usual inducements to designers be offered and the result awaited. The Corporation can keep the control in their own hands; they need be bound to no particular course, but they should give confidence to competitors by appointing one or more engineers of eminence to aid the judges of the designs.

We are the more anxious to recommend this course because we believe, from the reported discussions of the Corporation, that they are approaching the subject from too narrow and short-sighted a point of view. We have never disguised our own opinion that the ultimate solution of the difficulty—for the many circumstances to be considered undoubtedly render it difficult—is a low-level road bridge without openings, and a railway bridge in conjunction. We are fully aware that the time is not ripe for this, and that only on the lines recommended last year by Parliament is there any chance of an Act being obtained. Without the opening for masted vessels, the opposition would now, as in the past, either be fatal or would have to be met by extravagant compensation, equally prohibitory. But those who have best studied the growth of the Port of London, and who are acquainted also with the effect of opening bridges in a tideway, are very confident that in a few years' time the masted vessels will keep below the bridge, since there is really no great reason for them to come above it; and by that time the needs and demands of the railways north and south of the Thames will have grown, and they will not be unwilling to contribute handsomely to the previous outlay incurred in establishing so important a right of way. Therefore, while not advocating the slightest departure from the present condition of a low-level road bridge with mechanical openings, the possibilities and needs of the future should be considered so far as to design a bridge which will facilitate or allow for a future modification, or which, at any rate, will put no unnecessary impediment in the way of future improvement. This should be specially held in mind in regard to the foundations, piers, and abutments. Therefore, until inducements have been offered to the best bridge engineers to consider and solve all these points, we say that the City authorities would be betraying a trust in adopting such a design as that now propounded by the City architect; and we are strongly of opinion, if they do adhere to it, and go before a Parliamentary Committee without showing that they have taken every reasonable step to enlist the best talent, their proposals will be rejected, and the scheme taken out of their hands altogether. The observations of a technical journal upon a subject such as this are entitled to the careful consideration of the City authorities, and we trust that they may see their way to adopt our suggestion, made, as it is, with the best intentions, and with motives which we feel sure they share, of giving to London, for what will be the most important crossing over our noble river, the best and handsomest bridge that modern science will allow.

COMPETITIVE TRIALS OF TRACTION ENGINES.

THE Stockport trials have directed attention once more to the relative merits of the traction engines made by the comparatively small number of firms constructing these machines; and there is every reason to hope that we shall see again something like the competition of 1871, held at Wolverhampton by the Royal Agricultural Society. Although the trade in this class of engine is of comparatively small proportions, it possesses sufficient importance to render it desirable that improvement should be effected, and nothing is more likely to secure this than open healthy competition. There is one point, however, which it is quite possible may be overlooked in the action taken by the Royal Agricultural Society. Traction engines are of necessity far more costly than portable engines, and there can be no doubt that this circumstance tends powerfully to check improvement. The manufacturer has not only to consider what is good, but what he can sell. Not very many years ago a well-known firm produced a somewhat novel and, so far as can be ascertained, excellent type of traction engine. Not more than two or three were made, because it was found that farmers and others did not see their way to pay the additional price asked, and rendered necessary by the peculiarities of the machine. Now, let us suppose that the Royal Agricultural Society institutes a competition next year, and that in this competition the question of selling price is entirely ignored. What follows? One maker puts in engines of the kind that he sells daily. Another puts in a special engine. He wins the prize, and there the matter ends, so far as the purchasing public is concerned, because it is simply impossible to sell the costlier engine. We are not now referring to "racers," but to special types of engine. It may be well to be very explicit on this point. Of the two competing engines to which we have referred one may be a racer; that is to say, its fire-box is of copper; it has brass tubes, and more tubes than would be put in an ordinary commercial engine; it is got up with greater care too, and is in various respects carefully prepared to win. But the rival engine is not only a racer in this sense of the term, but something more. There is every reason to believe that a double-cylinder traction engine of the railway locomotive type would be in many respects superior to engines of the ordinary form. It could be made lighter, more easily carried on springs, and so on. But such a machine must be more expensive than one of the usual type, and has, indeed, up to the present, been found unsaleable because it cannot compete with its rivals in price. Such an engine might possibly distance all competitors. We venture to think that it would not be fair to award it a first prize, because it would have no chance of subsequently playing a useful part. A broad distinction must be drawn between this engine and an ordinary racing portable engine. The difference between this last and the commercial engine is above all a question of material and workmanship. The latter can be fitted with an iron fire-box of the same size as a copper box; its flues may be of iron instead of brass. Its finish may be less perfect, but in dimensions, in proportions, and in the relation of parts to each other, there need be little difference between the racer and the commercial engine. But the case is entirely different with an engine of a different type, which, however successful in the showyard or trial ground, may be quite unsuitable for production as a commercial engine. For example, a triple expansion compound traction engine, fitted with a condenser, might distance all competitors in the matter of consumption of fuel; but to give a prize to such an engine would be to waste it, because no one would pay for such a machine, which would indeed be quite unsuitable for the discharge of the ordinary and very rough-and-ready duties of a traction engine.

How, it may be asked, is it possible to prevent such engines being entered for competition? We reply that it is not only impossible to interpose a sufficient obstacle, but that it would be undesirable as well; but it is quite possible to prevent an abnormal machine of the kind from taking a first prize. Let it be clearly understood that price will be taken as a factor in the conditions determining the award, and the thing is done. We are quite prepared to hear it urged that the price set on the competing engine is no test of its real value; that false price lists have been regularly used, and so on. We do not propose for a moment the adoption of so crude an expedient as the adoption of the exhibitor's terms as a criterion of the real value of the engine. Competent engineering judges should be able to tell which of two engines must of necessity cost most, and this is all that is necessary. According to the existing practice of the Royal Agricultural Society, certain qualifications are awarded certain numbers of marks. To apply this principle to the case under consideration is very easy. For example, a double-cylinder engine must, other things being equal, be more expensive that the single-cylinder engine. Therefore, double-cylinder engines must be handicapped, by always awarding to them a smaller number of marks for "simplicity of construction," than will be awarded to single-cylinder engines. Of course the handicapping must be done with great judgment by highly competent and disinterested men, but it can be done. We wish it to be understood that we are not now asserting that double-cylinder engines are either better or worse than single-cylinder engines; but we do assert that, other things being equal, the purchaser must pay more for them than for single-cylinder engines. Of course we are not blind to the fact that double-cylinder engines may be sold for the same price as single-cylinder engines, but it will be found that the whole engine is in that case lighter, or has a smaller boiler, or less powerful gearing, or that in some way or other the purchaser is prevented from getting an extra cylinder, excentric rods, link motion, &c., for nothing; and this is quite justifiable. The only object we have in view is to secure that the prize or prizes shall go to the engine most likely to be really useful to a purchaser, and we repeat that the question of cost is inextricably mixed up with this, and that it must influence results in a way quite unparalleled in the case of portable engines.

In any competition worth the name there will be a classification of engines, and the double-cylinder type will be in one class and the single cylinder in another. The question is, shall there be two prizes of equal value, one for each

class? This is a point on which we prefer to reserve all expression of opinion for the present. We have spoken throughout as though the double-cylinder engine must be more expensive than the single cylinder, but this we have done only for the purpose of illustrating our arguments. While we hold that two cylinders must cost more than one, we do not pretend to assert that they must cost so much that they will be unsaleable. All our own predilections are in favour of two cylinders, either compound or not; but it is, we believe, far more important to the well being of the community, makers, and purchasers alike, to produce a good, saleable engine, than a nearly perfect, unsaleable engine. It will be a perversion of justice if the prize be awarded to a machine which is the first and last of its type; and we are, we think, greatly mistaken in the merits of the Royal Agricultural Society and the shrewdness of traction engine builders, if a road is not found by which the prize shall go to the most useful engine; and this condition cannot possibly be complied with by any machine which is, we will not say too dear, but the price of which is too high to permit it to find a ready market. Great reputations must not be built up on really impracticable machines.

It may be said that the adoption of our views will render the task of judges difficult of performance. We grant this. Difficulties are made to be overcome by resolute men determined to do what is right. But the whole subject is invested with difficulties. One of the special objects we have in writing as we do is to elicit through our correspondence columns some expression of opinion which may be a guide to the Royal Agricultural Society in any proceedings it may take in this matter. As an example of a difficulty, let us take the load-fuel test—so many tons drawn so many miles by so much coal. Now here a very grave injustice may be done unless the element of time be taken into account. There are, let us say, two engines; one has small wheels, the other large. The first hauls its load at two miles an hour, expanding steam fully, and working with much economy. It developes, we will say, 20-horse power indicated. The other, in order to get along at all, has to work steam nearly full stroke, travels at three miles an hour, and developes, say, 30 indicated horse-power. The fuel consumption of the latter per ton per mile will be much greater than that of the former, although the duration of a given run will be less. Is it fair to assume that it is the worse engine of the two? That will depend entirely on the value attached to time in this connection. Again, we have two engines nearly identical as to cylinders, and gearing, and wheels, but one weighs two tons more than the other. Is this a good thing or a bad thing? We might extend this list of problems were it necessary, but it is not, for every maker will find questions of the kind suggest themselves to him. Our earnest desire is that in any competition such as we contemplate the necessity for, the prize may go to that engine which is most likely to prove a friend to him who makes and him who uses it; and while we do not for a moment deprecate the testing of abnormal devices, we insist that care shall be taken that they do not obtain more credit for merit than is justly their due. As we have already stated, it would be quite possible to design a traction engine which would beat all existing engines out of the field as far as consumption of fuel per ton per mile was concerned, but it by no means follows that it is to such an engine the first prize should be awarded. Small consumption of fuel, unless accompanied by other excellent qualities, and reasonable selling price, is of very secondary importance.

FOREIGN STEAMERS AND BRITISH TRADE.

In The Engineer we have several times referred to the subject of the large portion of the trade of some of our coal ports which is in the hands of the foreigners. The subject is one that is growing much in public attention. At some of the coal ports for several months of the year there is a larger number of foreign vessels in the export coal trade than there is of English vessels; and in some of the Scotch ports, such as Burntisland, the proportion is very remarkable. It is now known that this is due mainly to two causes—foreign vessels bring over cargoes of timber to some of the timber ports and take back coal cargoes; and, in addition to that cause, these vessels have practically no oversight from the Board of Trade officials, and carry any cargo that they choose unchecked. Wages are less on board these foreign vessels; and to the extent of their number they can compete with success against British vessels. It is well, then, that the question should be thrust on the attention of the public, for it is one that ought to be brought before the Royal Commission on Shipping, so that it may be seen what are the causes of the want of even-handed justice in the dealings in our own ports between foreign vessels and our own. It is difficult to deal with such a question; but the fact remains that there is now a large portion of our export coal trade in the hands of the foreigner. It has been suggested that the decay of the small sailing craft of Britain is one of the chief of the causes; and if this were so it would be easy to build small steamers to carry coal to shallow water ports abroad, but it is probable that to do this there would have to be a relaxation of some of the rules of the Board of Trade in relation to manning and to the officials of the small vessels. The question is one that needs further probing, and the increasing attention it is receiving, and the growth of the foreign fleets, will force it into a prominence that will make it a fit subject for the Royal Commission to deal with when its labours are fairly begun.

LITERATURE.

The London Water Supply. By Colonel Sir Francis Bolton, C.E. William Clowes and Sons. 1884.

Last, but not least, among the official handbooks of the International Health Exhibition, we have a valuable compendium of facts concerning the water supply of the metropolis. The task of preparing such a book as this could not have been confided to better hands than those of Sir Francis Bolton, who is both familiar with the practical bearings of the subject, and has ready access to the best sources of information. The book is somewhat bulky, and with its numerous maps and elaborate tables, makes the regulation charge of "one shilling," specified on its front, appear like a whimsical method of selling at a loss. The Exhibition has been profitable, and so it matters little whether the handbooks pay or not. In the public interest, whether the book to which we now refer is a pecuniary success or otherwise, the issue of such a work is to be welcomed, as throwing light on a question involving several millions of money and closely identified with the public health. If Sir Francis Bolton, or the Society of Arts, or some enterprising publisher, will take care that a fresh edition of the book is issued every year, corrected down to the date of publication, a fair price may be demanded, and good service will be rendered to the community. The latter portion of the handbook, descriptive of the water exhibits at the "Healtheries," is an attachment which can be easily laid aside, forming as it does a mere appendix to the permanent matter. Concerning the general character of the contents, we must observe that, in addition to much that is decidedly readable and interesting, there is a certain amount of dry, formal information, such as could not be well omitted, although not very inviting. Utility has been the prime consideration, and the reader is presented with the law as well as the facts concerning water supply. A valuable feature in the book is an admirable coloured map, showing the districts of the London water companies, distinguishing the areas actually supplied from those which come within the parliamentary limits, and also showing the portions favoured with the constant supply. Each company has likewise its separate map, showing the boundaries of the parliamentary area and the actual supply, as well as the extent of the constant service and the situation of the works, such as the pumping stations and wells, the reservoirs, the filter beds, and the main line of pipes. In addition to the information conveyed by the maps, supplemented by extensive tables of statistics, Sir Francis and his helpers have put together in a very lucid form a mass of details, historical and descriptive, such as we have not yet seen on this particular topic. The author expresses his obligations to the engineers and secretaries of the water companies for their important contributions in aid of the compilation of the book, and to Mr. Philip A. Scratchley, who rendered valuable assistance in giving shape to the materials thus supplied. Should this book obtain the general circulation which we trust awaits it, some good will be done in placing before the public the data which may go to form a more correct idea than that which generally prevails as to the character of the London water supply. It is quite possible to present an ideal on this subject which may provoke dissatisfaction with the reality. But no one can dispute the fact that there has been an enormous improvement in the water supply in the metropolis since the period when the Thames Companies had their intakes in the tidal portion of the river. The extension of the impounding reservoirs, so as to avoid taking in water from the river during periods of flood, coupled with better means of filtration, has so promoted the purity of the supply as delivered to the consumer, that the objections which remain are simply those of sentiment. Into the controversy which has arisen on this point, the book now before us does not enter. With even-handed justice it gives the reports of Dr. Frankland on the one hand, and those of Messrs. Crookes, Odling, and Tidy on the other. Certain passages in the latter, which reflect somewhat severely on Dr. Frankland, are judiciously omitted as unsuited to the character of an official publication. But enough remains to vindicate the general water supply of London from the charge of being unwholesome. Looking to those pages in which we may expect to meet with the views of Sir F. Bolton himself, we find, as would be anticipated, a decided preference for the constant supply. Concerning the quantity received, a table is inserted, prepared from figures given by Sir Joseph Bazalgette, showing the wide variation in the volume per head in different cities. Berlin has little more than 13 gallons per head; Naples, 15; Rotterdam, 22; Paris, 36; New York, 61; Chicago, 102; Washington, 143; Marseilles, 158; and Rome, 160. Clearly all cannot be right. If none have too little, some must have vastly too much. Or else there is considerable loss in some cases *en route*. The mode of charge is another question. Sir F. Bolton admits that the charge by annual value encourages waste; but he does not go so far as to advocate the meter system. To a dual supply he offers grave objections, except where there is a possibility of separating the domestic consumption from that received for manufacturing and municipal purposes. There is a valuable chapter on "Water Filtration." Following this we have some pages showing "How London is Supplied." More than thirteen millions of money have now been expended on the works of the London water companies, and the description given of those works is well worthy of careful reading. Tables compiled by Mr. Alfred Lass contain statistical facts of great variety with regard to the finances of the water companies and the supply they afford to the metropolis; and towards the end of the book there are ample particulars as to the statutory powers and obligations of the companies. Sir F. Bolton, in the earlier pages, also renders an account of his own powers and duties as the Water Examiner under the Metropolis Water Act of 1871. On the whole, we may say that any reader, giving a fair consideration to the contents of this book, must be impressed with the elaborate and skilful manner in which an ample supply of water is provided, without failure or the fear of it, for a population continually increasing, and now verging on five millions. Sir F. Bolton admits that improvements may still be effected, and he distinctly asserts that the "distribution of water under eight different companies is not conducive to economy of management." This is doubtless true; but great security against a general breakdown is afforded by the distribution of the works over several centres. Free communication between these may be desirable, but their power of independent action should ever be maintained.

The Society of Engineers.—The secretaryship of the Society of Engineers having become vacant, the Council have appointed Mr. Charles Julian Light, C.E., to the position.

THE INSTITUTION OF MECHANICAL ENGINEERS.

An ordinary general meeting of this Institution took place on Wednesday, at 4 p.m., in the University College, Nottingham. The chair was taken by Mr. Chas. Cochran, and after the announcement of the names of the newly-elected members of various grades and of the names of those proposed for election to the position of president and of members of Council, papers were read by Mr. Alfred Slater and by Mr. Illius A. Timmis. The nomination list is as follows:—President, Mr. Jeremiah Head; Vice-presidents, Mr. George B. Rennie and Mr. Daniel Adamson; Members of Council, Messrs. W. Anderson, Francis C. Marshall, E. Windsor Richards, William Richardson, E. Hamer Carbutt, William Denny, Benjamin A. Dobson, Sir James N. Douglass, Alex. B. W. Kennedy, T. Henry Riches, and Henry Shield.

To all appearance this list seemed to give general satisfaction, and to promise a settlement of the difficulties which have marred the conduct of the Institution of Mechanical Engineers in the recent past.

The first paper read was that of Mr. Alfred Slater on the mineral wagons of South Wales. This paper briefly described the wagons in common use on the lines of the Taff Vale and the Great Western companies, and including coal wagons carrying from 6 to 10 tons, and a paying load per ton of tare of from 1·883 tons in 1883 to 2·116 tons in 1867. In 1875 it was 2·059 tons. The paying load per ton of tare has thus decreased, in consequence chiefly of the higher speeds at which mineral trains are now worked, and the correspondingly heavier construction of wagons necessary. The 6-ton wagon is now not built, the 10-ton having taken its place. The various dimensions of coal wagons and their details are given in the paper. In referring to the buffers, several spring forms were mentioned, and improved "outside" buffers described, one being arranged so that the blow is delivered direct to the sole bar instead of through the buffer beam. A form of iron frame was described, and reference made to iron frames made in 1844 and still in use, and to the reluctance on the part of wagon buyers to adopt this material instead of wood, although wood is dearer every year, and oak sometimes difficult to obtain at all. In the discussion on the paper, Mr. Clayton, of Derby, spoke at some length, and with reference to springs, spring buffers, and iron frames, made remarks which, as the result of experience, showed how very reluctant wagon buyers are, as a rule, to venture on an obviously beneficial change. Buffer springs or spring buffers are, for instance, universal on German lines, yet few of our wagons are so fitted. In Germany, it is admitted, as well as seen, that not only does the wagon last longer, but the compensation for damages of goods is much lessened. Iron is, moreover, largely used for frames and all parts of wagons, and for carriages, too, with every success; and, as Mr. Jeremiah Head remarked, one would think that railway companies through their locomotive and carriage and wagon superintendents would encourage the use of iron or mild steel for this work, as it would stimulate manufactures which themselves provide work for the lines. Mr. Robert Gordon referred to the wagons in the United States, which, like those now made for the Pennsylvania road, carry a load of from 50 to 70,000 lb., and weigh 20,000 lb. Mr. Hughes wanted to know why we had remained behind in the use of wagons of high capacity, and in reply was told that a capacity of more than about 10 tons usually involved many traffic inconveniences, and seldom any advantages. A truck load of 10 tons has moreover advantages which are understood by freighters as well as traffic managers. A greater quantity would, in brief, often be unhandy for several reasons.

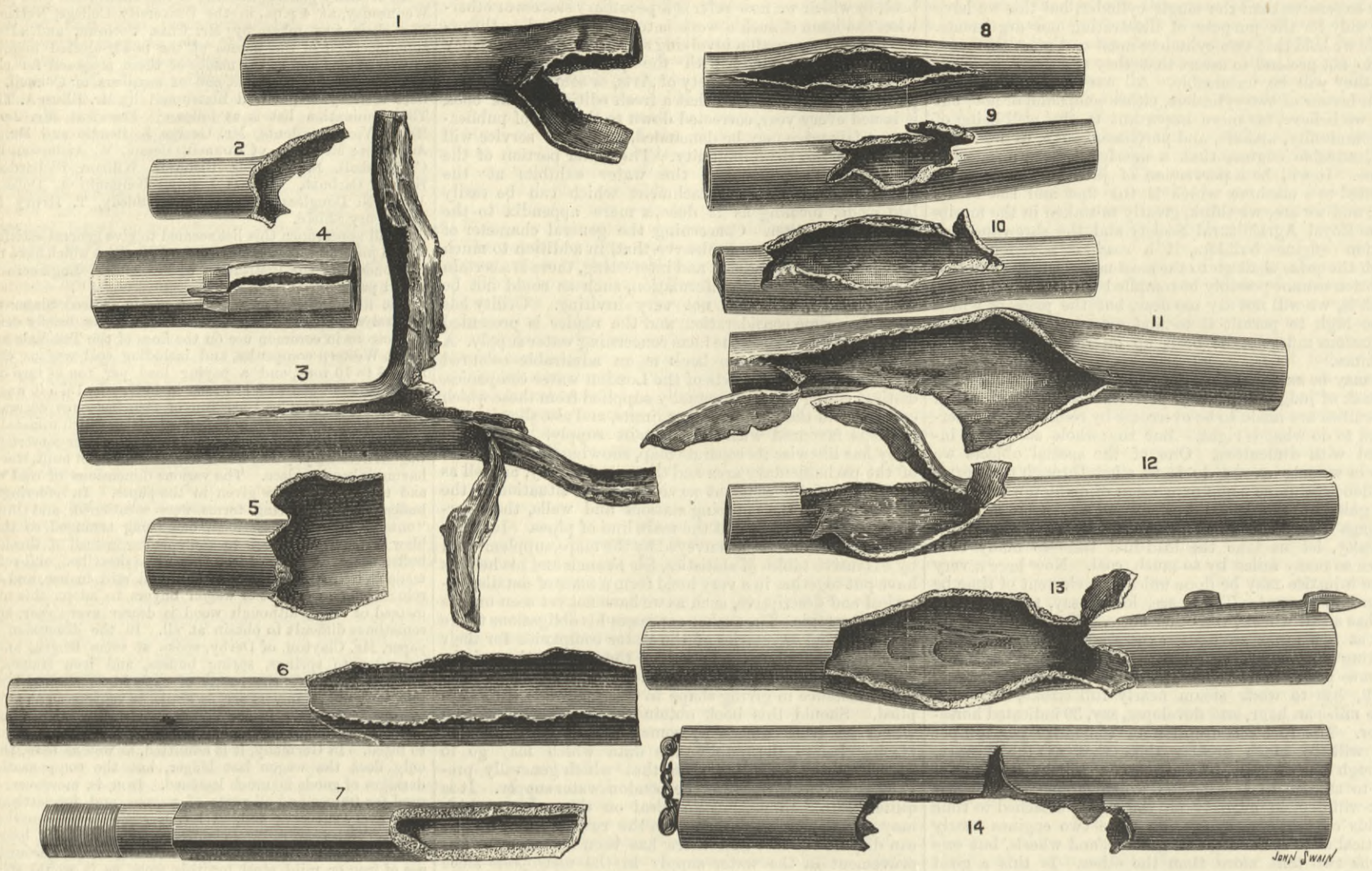
The paper by Mr. Timmis described the system of long pull electro-magnets for working and locking signals and points known by his name and that of Mr. S. Currie. It is unnecessary that we should quote this paper, as we fully described the system and the apparatus in The Engineer of vol. lvii., pp. 202 and 204. In the discussion on the paper, Mr. Crompton said he feared the difficulty which would attend the production of currents or the charging of batteries at small stations would make the system much more costly than that at present in use. It was in the regular provision of the electric currents at all the scattered stations of a great railway that he saw difficulties.

For an ordinary local meeting the attendance was good, a considerable number being from the London district. The discussions added little to the information given in the papers, as there were very few railway men present to take part in them.

School of Art Wood-carving.—We are requested to state that the School of Art Wood-carving at the Royal Albert Hall, Kensington, in connection with the City and Guilds of London Institute for the Advancement of Technical Education, has re-opened for the Winter Session with improved accommodation for pupils. Full particulars of the classes and the lessons by correspondence, also as to work executed in the school, can be had from the manager. We may add that the school has been awarded a silver medal in the Educational Section of the International Health Exhibition, and the following students have also obtained honours:—Miss M. E. Reeks, silver medal; Miss H. E. Wahab, bronze medal; Mr. D. Chisholm, bronze medal. The school also gained the highest award for wood-carving—a silver medal—at the Art Exhibition held in September last at Eastbourne.

Ship-lighting by Electricity.—On Friday evening, the 17th ult., a company of ladies and gentlemen met on board the paddle-steamer Olympo, to view the installation of the electric light. This steamer, which has been built by Messrs. A. and J. Inglis, Pointhouse, Glasgow, for the Mensagerias Fluriales, Avapor, is sister ship to the Saturno, recently built by Messrs. Inglis for the same owners, and is intended for passenger traffic on the River Plate. The installation consists of 320 incandescent lamps, of 20-candle power, which are divided into six circuits, each of which is controlled by a switch in the engine-room. Each state-room is provided with a lamp, having a separate switch under the control of the passenger. An adjustable resistance is placed in the field magnet circuit, and the speed of the engine is controlled by an "Auldo" reducing valve, placed close to the switch board. The dynamo used is one of the Elphinstone-Vincent type, capable of lighting 400 lamps, and runs at 900 revolutions per minute, with an electro-motive force of 90 volts. Over each gangway is placed a large lantern. Each lantern contains a group of six incandescent lamps, of 20-candle power. The lights are suspended over the gangways by strong brass swinging brackets, which can be shipped or unshipped at pleasure. By this means a splendid light will be thrown over the gangways when the passengers are being landed or shipped, or when loading or discharging cargo. A novel feature in ship lighting is the introduction of storage batteries. There are forty-five cells, which can be charged while the dynamo is running and lighting lamps; and this accumulated energy can be used for lighting any portion of the vessel when she is in port, and steam cannot be obtained. The engine used for driving the dynamo is one of J. and H. Gwynne's "Invincible" type. All the work connected with the installation has been carried out by Messrs. William Harvie and Co., Broomielaw, Glasgow, under the supervision of Mr. Montagu Scott, their chief electrician. The pendants, brackets, &c., which are of an elaborate description, were likewise designed and manufactured by Messrs. Harvie, who have carried out the work in a highly satisfactory manner.

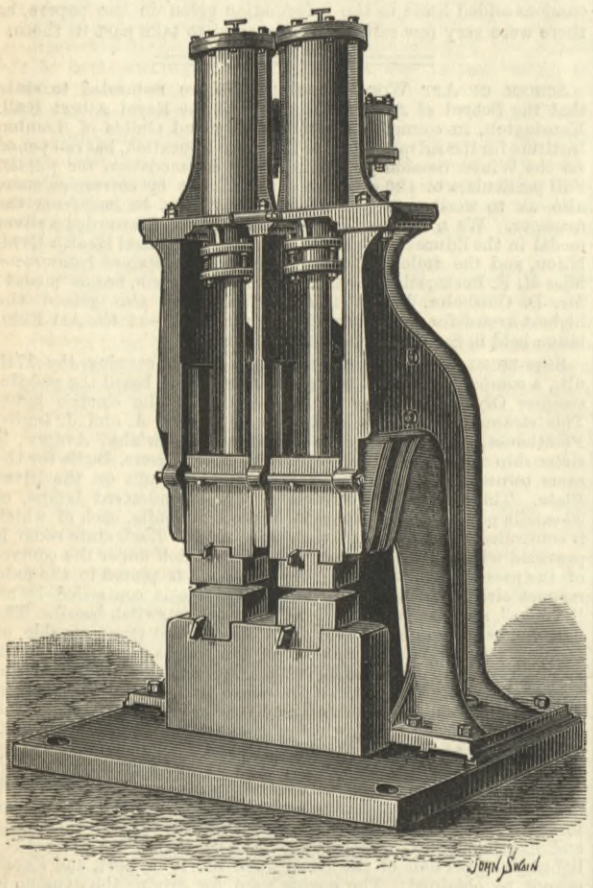
EFFECTS OF OBSTRUCTIONS IN GUN BARRELS.



The engraving above, copied from a photocollotype, shows specimens of firearms burst by Capt. W. McK. Heath, at Philadelphia, Pa., 1884, in some tests (supplementary to his small arms air-space experiments of 1882-3-4), to show the danger of firing guns (loaded as usual) when the barrel is obstructed The muzzles point to the right hand: every barrel is shown exactly as rent by the explosion. Nos. 1, 2, 3, 4, and 5—U. S. musket, Belgian Cadet musket, Mississippi rifle, W. Derringer's sporting rifle, and Prussian musket—burst by a bullet stuck at muzzle; 6 and 8—shotguns—snow at muzzle; 7—Remington navy revolver—a bullet stuck 2 inches from muzzle; 9—Cadet musket—stuck bullet, middle of barrel; 10, 11—U. S. rifled muskets—wet sand at muzzle; 12, 13, 14—U. S. rifled musket, Prussian musket and Webley B. L. laminated steel shotgun—mud at muzzle.

DOUBLE STEAM HAMMER.

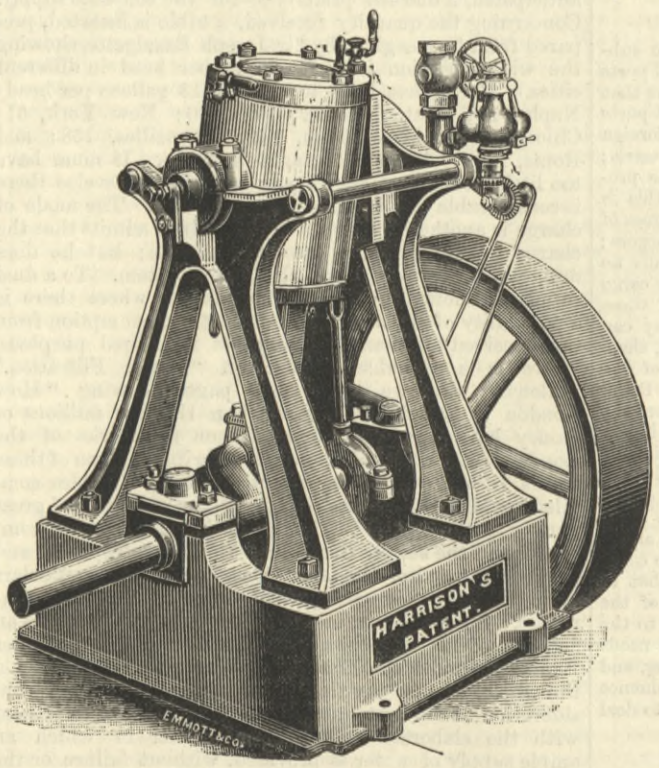
Messrs. B. and S. Massey, of Manchester, have recently constructed for Messrs. Tangye, Birmingham, a specially-designed double steam hammer. This was referred to a short



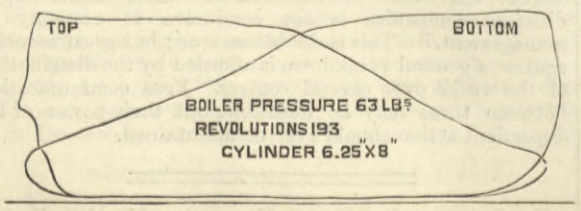
time back in the "Notes" of our Lancashire correspondent, and we now give an illustration with a further description. There are, as shown, two hammers of the same size, which can be worked either together or independently. By this arrangement one hammer may be delivering sharp and rapid blows whilst the other is striking slowly and heavily, or one may be stopped entirely whilst the other is at work. This arrangement of double hammers is intended principally for work which requires to be passed quickly from one to another at the same heat, and as the two tups or hammer heads are not more than about 4in. apart, this can be done with greatest facility. As compared with two separate hammers there is also a reduction in expense, as one base-plate, one anvil block, and the central member of the framing are common to both hammers. For the same reason there is also a saving in the foundation and in the floor space required. The falling weight of each hammer, independent of top steam, is 7 cwt. It may be added that the arrangement is applicable to three or more hammers should they be required, and is not confined simply to a pair of hammers, as shown in our illustration.

HARRISON'S PATENT VISIBLE SLIDE VALVE OSCILLATING ENGINE.

The accompaning engraving illustratesa curioustype of engine, invented by Mr. A. W. Harrison, of Abergavenny. The engine



ha: an inverted oscillating cylinder, 6¼in. by 8in. stroke. The slid: valve, which has two steam and two exhaust ports right thr:ough it, is planed parallel on both sides, and works



between the cylinder and steam chest faces; it is kept in its place by two strips, one of which is held by a set pin. By slackening this pin the valve can be taken out in one minute without breating any joint, and as quickly replaced. The cylinder oscillates on two solid conical trunnions, which work in gun-metal bushes screwed on the outside, so that by turning the link round it will take up any wear. The cylinder is kept up to its face by a set pin on the opposite trunnion to the steam chest. The valve is practically a balanced one, as the steam tends to press the faces apart, and the set pin to keep them together; the pin can be adjusted to a nicety. One of these engines has been working about two years, and sometimes it has been working for several days and nights together. We understand that on examination it was found that the tool marks were not worn out, and when working with 60 lb. of steam there was no leakage through the valve, yet the engine will work with 1½ lb. of steam, showing how little friction there is with the valve. The accompanying diagram was taken from an engine the same size as above, which went to New Zealand to drive a dynamo machine. At the bottom end of cylinder the pressure drops a little before the cut-off; this is from having the pipe to indicator carried from the bottom to top of cylinder with two bends.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—Joseph Minhinnick, chief engineer, to the Asia, for service in the Triumph; Henry G. Johnston, chief engineer, additional, to the Vernon; Henry L. Goldsmith, chief engineer, to the Asia, for service in the Emerald; Frederick P. Smith, assistant engineer, to the Alexandra; Edward Leigh Carte, engineer, to the Asia, additional, for service in the Euphrates; and W. E. Beal, chief engineer, to the Rambler.

Lecture on Tools.—At the Polytechnic Young Men's Christian Institute, for apprentices, artisans, and others, Regent-street, W., during the session 1884-5, a course of about thirty lectures on tools will be delivered by Paul N. Hasluck, Assoc. Inst. M.E., on Thursday evenings. The lectures will be divided into two series: First, metal working tools:—The lecturer will deal with the tools, appliances, manipulation and materials used in turning, fitting, smithing, and founding. Tool making: the different qualities and treatment of iron and steel used. Annealing, hardening, tempering, and case hardening. Grinding and setting tools for application to the various metals. Moulding plain and cored work and casting in brass and iron. Files: their forms, manufacture, purposes and manipulation. Lathes: hand turning, chucks, sliderests, boring, screw chasing, spinning, knurling, traversing mandrels, guide screws, and change wheels. Rose engines, dividing engines, planing, slotting, milling, and other machines. Straight edges, surface plates and measuring machines. Screw cutting with screw plates, dies, chasers, traversing mandrels and self-acting lathes; easy methods of calculating the wheels. Soldering, brazing, lacquering, &c. The second series will concern wood-working tools. The principles determining the forms, construction, cutting angles, and application of the various tools and their modification for use on hard and soft woods, ivory, &c. Lathes and the chucks and appliances used for plain, oval, and spiral turning, copying, fluting, &c. Planing, moulding, mortising, sawing, veneer cutting, and other machines. Work benches and appliances, as cramps, cauls, &c. Manipulation of hand tools in the practice of carpentry, pattern making, veneering, inlaying, fret cutting, parquetry, &c. Grinding and setting edge tools, &c. The lectures will be illustrated by specially prepared diagrams, models, and experiments. Students will be required to make at least twenty attendances, and to present themselves for examination in connection with the City and Guilds of London Institute, to be held at the Polytechnic on May 20th, 1885, when medals, money prizes, and certificates will be awarded. Additional prizes will also be presented by the Polytechnic Institute. The first lecture, to which all intending students are invited, will be given on Thursday, November 13th, 1884, at eight o'clock. Fees for the course: Non-members, 4s.; members, half fees.

THE FORTH BRIDGE.*

By B. Baker, M.I.C.E.

Two years ago I read a paper on the proposed Forth Bridge at the Southampton meeting of the British Association. Until the other day I had not since glanced at the paper, and a re-perusal was in many respects suggestive; for during the past two years the works have progressed, and some of the theories advanced in the first paper have been put to the test of actual practice. In one respect the re-perusal was a painful one, for the opening sentence contained a reference to Sir William Siemens, and I was reminded of the loss of a friend who took the greatest interest in the Forth Bridge, and whose vast experience and matured judgment could always be drawn upon in times of doubt or difficulty. Taking up the narrative of the proceedings from the date of my last paper, I may state, in the first place, that five tenders were submitted for the construction and erection of the bridge, the amounts varying from £1,487,000 to £2,301,760, and that the contract was finally let to Messrs. Tancred, Arrol, and Co., on the 21st December, 1882, for £1,600,000, which was within £5000 of the estimated cost of the work as prepared by Mr. Fowler and myself for Parliamentary purposes. The total length of viaduct included in this contract is about 1½ miles, and there are: two spans of 1700ft. each, two spans of 675ft. each, fifteen spans of 168ft. each, five spans of 25ft. each. Including piers there is thus almost exactly one mile of main spans, and half a mile of viaduct approach. The clear headway under the centre of the bridge is 150ft. above high water, and the highest part of the bridge is 361ft. above the same datum. Each of the three main piers consists of a group of four cylindrical masonry and concrete piers, 49ft. in diameter at the top and from 60ft. to 70ft. in diameter at the bottom. The deepest pier is about 70ft. below low water, and the rise of tide is 18ft. at ordinary springs. In the piers there are about 120,000 cube yards of masonry, and in the superstructure about 45,000 tons of steel. Operations were commenced in January, 1883, so the works have now been some twenty months in progress, and about £170,000 have been expended in plant and temporary works, and £200,000 in the permanent works of the bridge. At South Queensferry an area of about twenty acres of ground has been laid out in shops and yards for the manufacture of the 1700ft. span steel girders and for other purposes. These shops are in direct communication with the North British Railway, and are connected by an incline and winding engine with a temporary timber viaduct 2200ft. in length and 50ft. in width, extending from the South Queensferry shore to the first of the groups of four cylindrical iron caissons which constitute the lower portions of the main piers of the bridge. At Inch Garvie stores and offices have been built, and as this is an exposed island in the middle of the Forth, the staging for the pierwork is of iron pinned to the rock. Similarly at North Queensferry, on the Fife side of the Forth, stores, offices, and iron staging have been erected. The state of the works at the present time is as follows:—

Piers.—South Queensferry main piers: One of the 70ft. diameter caissons has been sunk to a depth of 16ft. below low water, a second is in position, and the two others are advanced to the required extent to follow on. Inch Garvie main piers: One of the piers is practically complete, another is well advanced, and the pneumatic caissons for the other two are being constructed. Fife Main Piers: Three of the piers are built and the remaining one is in progress. Cantilever end piers: One of these piers is carried to a height of 66ft. above high water, and the other to a height of 6ft. above low water. Viaduct piers: Eleven out of the total number of thirteen piers are built up to the height at which it is proposed to erect the girders in the first instance before final raising into position by hydraulic jacks.

Superstructure.—About 3000 tons of steel have been delivered for the 1700ft. spans. The first portion to be erected will be that over the Fife main piers, and the bed plates, skew backs, and 12ft. diameter tubes for this work are well advanced. A further quantity of 1100 tons of steel girder work for the approach viaduct is now in course of erection.

Plant.—The plant includes fourteen steam barges, launches, and other vessels; twenty-two steam, twelve hydraulic, and thirty-eight hand power cranes; twenty-eight single and double engines for shop machines, hydraulic work, air compressing, electric lighting, pumping, and other purposes; also gas furnaces for heating the steel plates, a 2000 ton hydraulic press for bending them, and planing machines, multiple drills, hydraulic rivetters, and other specially designed tools too numerous to mention. Having reference to the novelty and magnitude of the work, and the amount of preliminary preparations required, it may be considered that fair progress has been made during the past twenty months. No special difficulties were encountered in founding the viaduct piers, notwithstanding their exposed position. Except in two cases the piers rest on the rock, and they were executed in half-tide or whole tide cofferdams, which call for no special remark. The cofferdam for the south cantilever end pier was necessarily a very substantial structure, being a-quarter of a mile from the shore. It measured 126ft. by 75ft. over all, and had a double row of whole timber piles, with 4ft. of puddle between, and internal struts, chain cable ties, and external raking struts and piles of great strength and solidity. A highly satisfactory bottom on boulder clay of rock-like hardness was found at a depth of 35ft. below high water. The masonry of the viaduct piers and cantilever end piers consists of an Aberdeen granite facing, averaging a little over 2ft. in thickness of rock-faced work, backed up with cement concrete or with rubble masonry set in cement, and bonded, about every 12ft. in height, with courses of large stones carried across the entire area of the piers. The main piers have on the whole, perhaps, given more trouble than was anticipated. On the Fife shore the whinstone rock bottom falls with a rapid slope of about 1½ to 1 to deep water, and it was necessary to step this slope for the masonry. Diamond drills worked from an iron stage were employed for the subaqueous blasting; but the removal of the rock proved a most tedious affair, and a substantial timber and clay cofferdam had, after all, to be constructed for one of the piers. With some trouble, the other pier was built within a makeshift half-tide dam, made up partly of the 60ft. diameter permanent iron caisson below low water, with a temporary iron caisson attached to it, the whole made tight to the rock as far as might be with concrete and clay filled in between the caisson and a few buckle plates. At Inch Garvie similar delay and trouble were experienced in carrying out the shallow piers. Some of the work could only proceed at low water of spring tides, and it generally happened to blow hard just at that long waited-for moment. Tidal work, and even half-tide work, are proverbially slow and worrying; but we were all determined that, as the rock varied in quality, no foundation should be put in until the bottom had been laid dry. By perseverance and patience this has hitherto been accomplished, and we have the satisfaction of knowing that both the rock foundation and masonry are unexceptional in strength and solidity. In our shallow rock foundations at the Forth we had much the same problem to deal with as Stephenson encountered, thirty years ago, when building the fine bridge across the St. Lawrence at this city, and our contractors dealt with it in much the same way. I am not concerned to defend the operations, as such details are usually left to those responsible, namely, the contractors. Where speed is required, I am satisfied that in most cases pneumatic appliances offer incomparable advantages over cofferdam work on a rock bottom. French contractors generally resort to pneumatic caissons of ordinary type in depths exceeding 15ft., but have employed, with great advantage, modifications known as the *caisson-batardeau*, the *bateau-plongeur*, &c., in depths as little as 6ft. The six weeks required to build a pier with the aid of pneumatic appliances may often be taken up in stopping the leaks of a cofferdam on rock bottom. English contractors are not much accustomed to pneumatic appliances, other than an ordinary diving dress, and rarely resort to them. A diving bell, with shaft of access and air lock, was provided and mounted on traveller complete at the Forth, and compressed air drills were fitted in the working chamber, but no use has hitherto been made of the apparatus. The lower part of the South Queensferry main pier consists, as already stated of a group of four pneumatic caissons 70ft. in diameter. In the contract the option was allowed of sinking open-topped caissons by dredging inside, but, after experiencing the extreme hardness of the boulder clay, we were all agreed that it would be preferable to resort to the pneumatic process. Owing to the slope of the clay the four caissons will be sunk to varying depths, ranging from 68ft. to 88ft. below high water. The caissons, which were built on shore, launched, and floated into position, are 70ft. in diameter at the cutting edge, and taper 1 in 46 to facilitate sinking. At 1ft. above low water, which is the top of the permanent caisson and commencement of the granite-faced masonry, the diameter is 60ft. A working chamber 7ft. high is provided at the bottom of the caisson, the roof of which is supported by four strong lattice girders 18ft. deep, and cross girders 3ft. deep spaced 4ft. apart. An internal skin 7ft. distant from the external skin, and vertical diaphragms, form pockets which can be filled with concrete at any point where, owing to the slope of the ground, and the varying hardness of the silt and clay, a heavier pressure is desired to force down the caisson. Three shafts, 3ft. 6in. in diameter, with air locks at the top, pipes for admitting water and ejecting silt, and other of the usual appliances are provided. The air locks for passing out the clay and boulders, as designed by Mr. Arrol and myself have, instead of the usual hinged doors, two sliding doors like horizontal sluice valves, across the 3ft. 6in. shafts, which are worked by little hydraulic rams, or by hand, and are interlocked like railway points and signals, so that one slide cannot be opened until the other is closed. Mounted on the side of the air lock is a steam engine which, by means of a shaft passing through a stuffing-box in the side of the air lock, and a drum inside, winds up the excavated material in skips containing one cubic yard. The operation of hoisting, opening slides, and discharging is rapidly performed, so the two locks have a large working capacity. A third air lock, with side doors, ladder, and hoist, is also provided for the men. The air-compressing plant consists of three engines with 16½in. diameter by 24in. stroke steam and air cylinders, ample power being furnished by boilers of the locomotive type erected on the staging. Reference has already been made to the two shallow piers at Inch Garvie, but there are also two deep piers which, being on a very irregular and sloping rock bottom, have required much consideration. It was finally decided to level a bed roughly with bags of sand, and to float out pneumatic caissons, and excavate the rock until a level bed was cut. Probably Mr. Fowler and I would not have adopted this precise plan if we had been contracting, although we might have resorted to the pneumatic process; but as M. Coisseau, a contractor of great experience in such work, offered to sub-contract for the sinking of the caissons at fair rates, we did not object. These caissons are 70ft. in diameter at the bottom, and the rock slopes from 14ft. to 19ft. in that length, the lowest point being 75ft. below high water. All of the pneumatic caissons will be filled with concrete up to low-water mark, the mixture being 27 cube feet of broken whinstone, 7 cube feet of sand, and 5½ cube feet of cement, which together make a full yard of concrete, having a crushing resistance of about 50 tons per square foot. Above low water the cylindrical piers, which are 49ft. in diameter at the top, 55ft. at the bottom, and 36ft. high, consists of the strongest masonry, the hearting being flat-bedded Arbroath stone with both horizontal and vertical bond, and the facing Aberdeen granite, the whole set in two to one cement mortar, and built in the dry within temporary wrought iron caissons. In the shallow piers where the rock is stepped the masonry is carried down to the rock itself, and wrought iron hoops 36in. by 1½in. bind the bases of the piers. At the top of all the piers 18in. by 1½in. hoops, and midway down 18in. by ⅜in. hoops, are also built in, and it is believed that these cylindrical masses of masonry are as completely monolithic as can be attained or desired. In each cylindrical pier there are forty-eight steel bolts 2½in. in diameter and 24ft. long, to hold down the bed-plates and superstructure of the main spans. A few words now as to the manufacture of the superstructure. About forty-two miles of plates have to be bent for the tubular compression members, and the best method of doing this became a question of great practical importance. Bending cold did not answer, as the true curvatures could not be so attained. Theoretically, a 10,000-ton hydraulic press would be required to bend truly our 16ft. by 1½in. thick steel plates, and practically a 2000-ton press was of no use. Heated in a gas furnace, the plates bent readily, but distorted considerably and irregularly in cooling. Covering with ashes, packing up, and a variety of expedients were tried before the proper method was hit upon, which was to bend the plates hot and to give them a straightening squeeze afterwards when cold. Uniform heating is secured by admitting the gas near the door and midway along the furnace, and an important incidental advantage of the use of tubular compression members thus is that every plate gets relieved from any internal strains which may have been set up by shearing or improper usage at the steel works, which is of the greater moment as steel having the comparatively high tensile strength of 34 to 37 tons per square inch is used for the compression of members. Some alarm was occasioned at the works by certain 1½in. thick plates breaking like cast iron on being bent cold to the flat radius of 6ft. I felt certain, however, that the Landore steel was not at fault, as our inspectors test a shearing from every plate by bending it round a radius of 1½in. after being made red-hot and cooled in water. On investigation I traced the cause of the fracture in the local damage the plates received from shearing. What the damage consists in is an unsolved riddle. It cannot extend more than $\frac{1}{16}$in. from the edge, because planing to that extent relieves the plate and yet it affects the entire width, for the 4ft. 6in. plate snapped as readily as the 1in. wide strip sheared from it. Neither can it arise from nicking by bad shearing, because making the plates red-hot cures the evil, though the nicking, if previously existent, remains as visible as ever. Practically, the important point of interest to bridge builders is that with planed edges and drilled holes we have had no mysterious fractures, but the Forth Bridge plates have behaved as a material having as the higher limit a tensile strength of 37 tons per square inch and an elongation of 17 per cent. in 8in. should behave. Our specification for steel in compression is 34 to 37 tons with an elongation of 17 per cent., and for steel in tension 30 to 33 tons with 20 per cent. elongation. The strength rarely varies as widely as the stated limits, and the elongation averages some 3 per cent. more. One of the plates which fractured from sheared edges when bent cold was tested by me in a variety of ways. A specimen made red-hot and cooled in water at 80 deg. stood 38·3 tons per square inch and elongated 21 per cent. Another specimen made hot and allowed to cool in air stood 36·6 tons and also elongated 21 per cent., whilst one planed from the plate direct without heating failed with 34·3 tons, but extended 25 per cent. For practical purposes, therefore, it mattered little how the plate was treated, provided the effect of the shearing was eliminated by planing or by heating. When bent, the plates are planed at the edges in the usual way, and at the curved ends by a specially-designed radial machine. They are then, with the internal stiffeners, temporarily built into a tube round a mandrel, and drilled through plates, covers, and bars at one operation. Four specially-designed annular drill frames, surrounding the tubes, and furnished each with ten traversing drills, capable of attacking every hole, travel along lines of railway in the building yards, so laid out that four lengths of tube, each of about 400ft., can, if desired, be dealt with at once. In a 16ft. length of 12ft. diameter tube there are about 1600 holes to drill through from 2¾in. to 3¾in. thickness of steel, which operation takes about 52 hours' working of the drills. Continuous working is, of course, not possible, as the machine has to be advanced every 8ft., which is the shift of the butts in the plating of the large tubes. Over the piers the arched tubular lower member forms a connection with the upper bed-plates, the vertical and diagonal tubes, and the lateral and vertical cross bracing, so that considerable thought had to be given to the details at this point. A full-sized model was prepared, and different modes of arranging the junctions were set out and modelled. Finally it was decided to gradually change the tubular lower member into a box form with one rounded upper corner, where it meets the skewback or part over the pier, and by internal vertical and horizontal diaphragms, to make the latter a cellular structure of enormous strength and stiffness, offering facilities for attachments in any required direction. Several layers of plates form the bottom of this skewback, and constitute what may be termed the "upper bed-plate" of the bridge. The "lower bed-plate" consists of similar layers of plates rivetted together and bolted to the pier; and the two bed-plates are free to slide on each other within certain limits to be referred to more particularly hereafter. The layers of plates run longitudinally and transversely, to meet the different stresses; and, after the edges are planed, the plates are fitted together, clamped between girders, and drilled by special machines through their whole thickness. About 1000 lineal feet of 1⅛in. holes have to be drilled in each bed-plate, which in practice with the 8-drill machine, takes about eighteen days, including stoppages. In the upper bed-plate holes about 11in. square, with corners rounded to a 3in. radius are required, in some instances, to clear the nuts of the holding down-bolts, and these are cut readily by a simple tool devised by Mr. Arrol. In other cases, 12ft. diameter recesses, 2in. deep, have to be bored for what may be termed a huge key or dowel, which will connect the upper and lower bed-plates, but allow a slight rotation; and this also requires a special tool. The tension members and cross bracing generally consist of box lattice girders, which are drilled by travelling machines of similar type to those already referred to in connection with the tubular members. All of the rivets are of steel, having a tensile strength of about 27 tons, an elongation of about 30 per cent., and a shearing resistance of from 22 tons to 24 tons per square inch. It is hardly necessary to state that hydraulic rivetting will be used throughout. The nuts and washers of the holding-down bolts and some other parts are of cast steel, having a tensile strength of 30 tons per square inch. and an elongation of 8 to 10 per cent. It may be interesting to mention that the contractors have used steel in preference to iron in some parts of the temporary works, and that at their request the 168ft. span viaduct approach girders were changed from iron to steel with a view to save expense. The two years' additional consideration given to this bridge since the date of my first paper, has led to no modifications of importance in the design, or in the weight of steel required for the construction, a satisfactory result which is largely due to the care and ability of my colleague Mr. Allen Stewart, who has had charge of the detailed calculations and designs from the inception of the undertaking. Originally the cantilevers had a varying batter towards each other from 1 in 7½ at the piers to vertical at the ends, where they meet the central girder. We have now made the central girders slope inwards and maintained the batter of 1 in 7½ throughout, thus getting rid of the previous "winding," which somewhat complicated the details of the cantilever, and at the same time preserving and emphasising the pyramidal form of cross section characteristic of the design. In models of the bridge a feeling of great solidity results from this feature, as will be the case no doubt in the bridge itself, of which a geometrical elevation necessarily gives but a poor idea. We have also modified the attachment of the superstructure to the piers. Formerly the intention was to put an initial stress upon the 12ft. tubes between the double piers, as described in my first paper, and to bolt the superstructure rigidly to the masonry. Now we secure the superstructure to one only of the four cylindrical piers in each group by the great circular key already referred to, and permit a certain amount of sliding on the others. Owing to the enormous size of the structure elastic deformations which may be neglected in ordinary cases have to be provided for. A very great deal of consideration has been given to this important point, and the calculations have necessarily been complex and tedious, but we think we have now made the best disposition attainable to resist all possible and improbable hurricanes striking the bridge locally or throughout the whole span, and all variations of temperature likely to be met with at the Forth. The question of clothing the tubes between the piers with some non-conducting material will be left for future settlement after the movements under changes of temperature have been registered by the tube itself. Fortunately we are not troubled with Canadian variations of temperature, and the correspondingly great changes of form in metallic structures. At the New Clyde Viaduct in a length of 376ft., the observed annual range is 2in., or a fraction over half an inch in the 100ft., and this is an open lattice construction, whilst the Forth Bridge horizontal members between the piers are closed tubes. Obviously during the early stages of erection, before much weight comes on the bed-plates, the tube will be practically free to expand and contract. Ultimately, when the whole weight of the completed structure rests on the piers, the friction between the two surfaces of the upper and lower bed-plates will probably be sufficient to prevent movement except under extremes of temperature and heavy wind pressure of rare occurrence. The attachment of the superstructure to the piers partakes thus of the character of a safety friction clutch. Movement will not occur under ordinary circumstances, and if an excessive shock from some unforeseen cause arise on the superstructure, it can only be transmitted to the masonry of the pier through the sliding surface of the upper and lower bed-plates. Should a wave of deflection from the impact of a tornado pass along the great cantilever, as some critics suggest, then it would be arrested by skidding as an express train is arrested, and not by running into a buffer stop. Provision is made for lubricating the surfaces, and as the result of experiments made by myself during the past two years, probably some crude petroleum will be applied to the bed-plates every time paint is applied to the rest of the bridge. Calculations have been made of the extent of sliding and of the stresses on the piers under the twisting action of a hurricane blowing on one cantilever whilst the balancing cantilever is in a dead calm, and various coefficients of friction have been assumed. During erection sliding can, if desired, be made practically free by carrying one cantilever further out than the balancing one, and so relieving two out of the four bed-plates of weight. In the completed bridge the position of the bed-plates could be adjusted by temporarily loading the end of a cantilever. Experiments on friction vary considerably, but when such large surfaces as 2200 square feet, which is the joint area of the four bed-plates of each main pier, are concerned, there would no doubt be an equalising effect which would make the proper coefficient of friction for the bed-plates approximate to the mean of the results obtained with a number of experiments on small areas. The coefficients obtained by Morin for iron on iron greased ranged from ·09 to ·115, and with the grease wiped off, ·16 to ·19, the pressure being about 27 tons per square foot, or considerably greater than that on the Forth Bridge bed-plates.

(*To be continued.*)

* Paper read before the British Association.

Association of Municipal and Sanitary Engineers and Surveyors.—The Yorkshire district meeting will be held at Leeds, on Saturday, November 8th, 1884. The members will assemble at the borough engineer's office, Municipal Offices, at 10.30 a.m. A paper will be read as follows:—"Some remarks on Sewering Towns on the Separate System," by Thos. Hewson, M.I.C.E., borough engineer, Leeds. Discussion to follow. An inspection will be made of various kinds of brakes, used by the Leeds Tramway Company, in actual working; also the electric lighting of Municipal Offices. At 12.30—Luncheon. After which a visit will be paid to some of the following places, to be decided by a majority of the meeting, viz.:—Eccup Reservoir, belonging to Leeds Water Works; Outfall Works, at Knosthorp; Manlove and Allot's Refuse Destructor; Messrs. Wilcock and Co., Tarence Works Burmantofts.

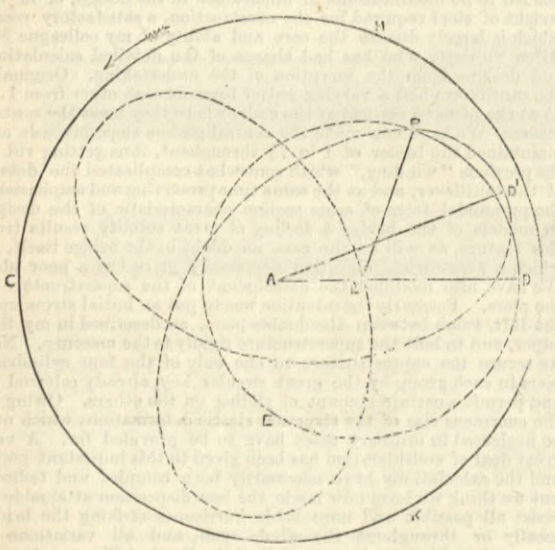
LETTERS TO THE EDITOR.

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

THE ACTION OF A REVOLVING CUTTER ON REVOLVING WORK.

Sir,—With the hope that it may be acceptable to those of your readers who are interested in ornamental turning, I beg to offer you a brief analysis of what appears to me a simple mode of producing curves of the roulette class. I must own, however, that my experience regarding lathe machinery is too limited to enable me to assert that I am right in all my conclusions. True as the principle doubtless is in theory, there may be difficulties in the carrying of it out. The chief of these possible difficulties I shall touch on before concluding my letter.

The name roulette is applied, by mathematicians, to any curve generated in space by a point carried on the radius or the radius produced of a circle, which circle rolls round another circle. The moving circle is called the generating circle, while that on which it rolls is called the base. The result, however, is evidently the same if we suppose the centres of both circles to be fixed points, and the base, instead of being stationary, to revolve on its centre; only that in this latter arrangement the curve will be traced on the plane of the base circle, and will revolve with that plane. The mathematical investigation of roulette curves will be found in most treatises on the differential calculus—see also Salmon's "Higher Plane Curves." If the generating circle rolls on the exterior of the base, the curve is termed an epicycloid or an epitrochoid, according as the tracing point is in the circumference or not in the circumference of the former circle. If the generating circle rolls on the inside of the base, the curve is either a hypocycloid or a hypotrochoid, according as the tracing point is in the circumference or not in the circumference of the former circle. The epicycloids and hypocycloids have cusps at the points, which correspond to the termination of any revolution of the generating circle and the beginning of the next. In the epitrochoids and hypotrochoids the cusps give place to nodes, leading to inner loops when the tracing point lies beyond the circumference of the generating circle; and I may here remark that these forms of roulette are generally the most beautiful, and therefore best adapted to lathe work. When the tracing point lies within the circumference of the generating circle, the curve assumes the form of a wave line, the waves being separated by points of inflection.



The plan I suggest for the production of these curves is the following:—H C K—*vide* figure—represents the disc, of wood or other material, on which the curve is to be cut, and A the axis of the mandril on which it is mounted. B is the axis of the cutter shaft, which is parallel to the mandril, and may be supported on the slide rest or on other suitable framing placed across the bed of the lathe, the distance A B between the two axes being capable of adjustment. The cutter projects from an arm, or, perhaps better, a circular plate, carried on the extremity of the shaft B. In the figure the cutter is at P, the circle D P E being that of its revolution. The length of the arm B P is alterable by means of a screw. All details of framing, driving pulleys, &c., are omitted as unnecessary in explaining the principle of the arrangement. Suppose, now, that while the mandril revolves once, the cutter, driven from the overhead motion, makes N revolutions, N being an integer or a fraction, and positive or negative, according as the shafts revolve in the same or in opposite directions; then it is clear that the cutter will groove out a curve in the face of the disc, and that this curve will be, except in the case where N = 1, one or other of the curves I have just mentioned, for two circles can always be described from the centres A and B touching each other, and having the ratio between their respective radii = N. These circles will then have rolling contact together; that of which A is the centre we must regard as the base, while the other is the generating circle. Putting A B = d, and B P = r, the particular form of curve will depend on the values of the three quantities N, d, r. It may also be observed that if N be positive, the curve will be either a hypotrochoid or hypocycloid, and that if N be negative it will be either an epitrochoid or an epicycloid. Moreover, it can easily be shown that the radii of the two circles which, by rolling together, produce this curve, are $\frac{d}{N-1}$ and $\frac{N\,d}{N-1}$, the greater or lesser radius being that of the generating circle, according to circumstances. The curve is an epicycloid or a hypocycloid—according to the sign of N—when $r = \frac{d}{N-1}$.

The curve exhibited in the figure is a hypotrochoid obtained by making N = 3 and r greater than d. Where $r = d$, the curve would consist of three lobes meeting in a centre at A. As a rule, when N is a positive integer, and $r = d$, the figure will consist of N lobes ranged at equal angles round A, the point through which the cutter passes at each revolution. Supposing the cut to have commenced when the cutter P was at D, the arc D^1 P has now been cut, the work having turned through the angle D A D^1, while the cutter has turned through the angle D B P = 3 D A D^1.

The following cases merit attention:—N = 2 gives the ellipse as a form of hypotrochoid. The semi-axes are the sum and difference of r and d. When $r = d$ the minor axis vanishes, and we have for the curve a straight line in length = 2 d, which is the corresponding hypocycloid. N = −1 and N = ½ produce the same curve, viz., the limaçon; in the one case it is an epitrochoid, in the other a hypotrochoid. There are other cases in which two different values of N give the same result. Making N = 1 furnishes an exceptional result, inasmuch as the curve, a circle whose centre is at a distance r from A, and radius = d, cannot apparently be derived from the rolling together of two circles. Two of the most remarkable figures are obtained by giving N the values −3 and $-\frac{3}{2}$, r in both cases being = d.

If, instead of making N exactly = 2, which would produce the ellipse, we make $N = \frac{2n}{n \pm 1}$, where n is some integer, at least as great as 10 say, then the figures will consist of n similar elements—lobes we may call them—extending across the disc, their vertices being separated by equal spaces. Other values of N may be dealt with in the same way.

And now a word or two regarding the arrangements for driving the cutter shaft. To drive it by a train of wheels from the mandril shaft would be out of all reason, owing to the enormous expense such gearing would involve, supposing it to admit of many changes of velocity ratio. In driving the cutter shaft from the overhead motion, a friend who professes to have some knowledge of lathe work suggests the following difficulties as likely to arise:—First, the difficulty of obtaining pulleys whose diameters bear to each other the exact ratios required. I doubt whether this is not pure fancy on his part. Secondly, the liability of some amount of slipping in the pulley band, thereby spoiling the curve cut. Well, I will admit that this may occur to a careless workman, but I venture to think that by having the band taut, and commencing the cut with a sufficiently light application of the cutting point, there will be no difficulty in avoiding this slipping. However, on both these points I submit my own opinion to the opinions of men of more experience in such matters than myself.

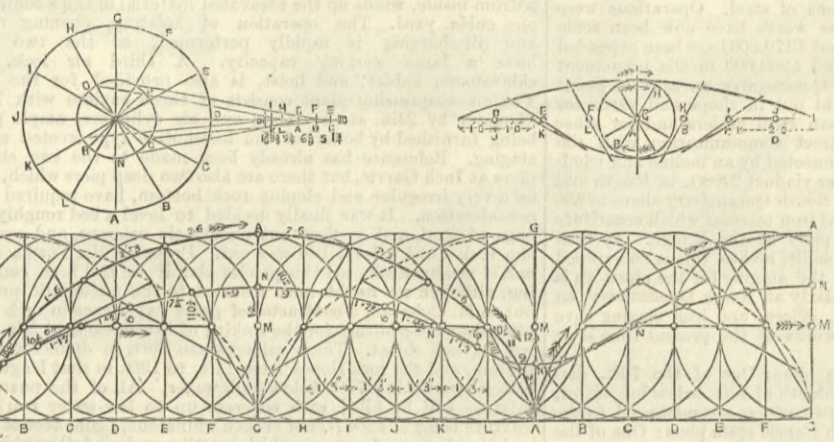
John R. Campbell, Lieut.-Col.

Charing, Ashford, Kent, October 19th.

LOCOMOTIVE CRANK AXLES.

Sir,—Your able remarks in The Engineer of the 24th, on the structural defects and ailments of crank shafts, suggest a wider field of inquiry as to those of the locomotive, for though the power applied to them is received and transmitted in a similar manner, the shaft of a fixed engine has a regular rotating speed, while that of the locomotive has a constantly varying velocity, and is, in addition, subject to lateral and vertical blows and forces, tending to its lamination and destruction.

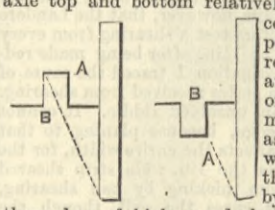
In order to exemplify my meaning as to the varying speeds of the surface of the axle itself, let me take the case of a wheel 5ft. diameter, with twelve spokes, or with twelve points in its circumference equidistant from each other, assuming them to be 15in.



apart, and with a crank in the line of one of them. Placing the crank below the centre, and vertically with it, we shall have the position which I will call A, and take that as a starting point, the crank centre being called N, and the wheel centre M, for short reference. At A and G the points A and N are vertical; at D and J they are horizontal. From a sketch before me I take the following approximate figures as giving the several positions:—

	A. Above rail advance.		N. Above rail advance.	
	ft. in.	ft. in.	ft. in.	ft. in.
A vertical	—	—	1 6	—
B ,, ...	0 4	0 0½	1 8	0 9
C ,, ...	1 4	0 4	2 0	1 7½
D ,, ...	2 6	1 3	2 6	2 9
E ,, ...	3 10	2 9	3 0	4 1½
F ,, ...	4 8	5 0	3 4½	5 9
G ,, ...	5 0	7 6	3 6	7 6
H ,, ...	4 8	10 0	3 4½	9 3
I ,, ...	3 10	12 3	3 0	10 10½
J ,, ...	2 6	13 9	2 6	12 3
K ,, ...	1 4	14 8	2 0	13 4½
L ,, ...	0 4	14 11½	1 8	14 3
A ,, ...	—	15 0	1 6	15 0

It will be easy for any of your readers to construct a curve from this table, and to verify it by setting out the several positions; and he will no doubt be surprised at the path of a given point in a rolling wheel, and by the fact that while the crank centre is below the horizontal centre line or path of M, the 5ft. wheel advances only 2ft. 6in., while the distance rolled over while it is above the line is 12ft. 6in. So, also, the crank has twice the stroke, less advance, below the centre than above it, or 5ft. 6in. and 9ft. 6in. What is true for the whole must be true for a part; and as a rolling wheel must of necessity stand on its lowest point, the speed of the top point of a wheel must be double that of its centre, because it has only the same space of time in which to travel twice the distance; so, also, there will be a difference in the speed of an axle top and bottom relatively to the distance from the point of contact with the rail to the two points of the bearing. The blows received by the wheel from the rail are much diminished by the system of fishing the rails, but there are still more than enough to cause accidents, as any passenger can tell who thinks what causes produce the motion of the carriages. All the jolting is felt by the crank axles, especially in these days of high speed; but this is little in comparison to the side strains caused by sharp curves, points, and crossings; and it would be interesting to know what should be the size of an axle carrying twelve tons at fifty miles an hour for a wheel suddenly striking the points at the entrance to a sharp curve, the axle being in either position, as sketched, at A or B.



What said George Stephenson? "Put no flange on your middle wheel, which should be the driving wheel." And again: "As the top of your wheel goes at twice the velocity of the train, put your brake there; it will have better effect." These dicta may be challenged, but the Patent-office holds the proof that I am correct on these points.

Is the crank axle a necessity? Mr. Trevithick, of the Grand Junction Railway, Mr. J. V. Gooch, of the London and South-Western Railway, Mr. Allen, of the Scottish Central Railway—formerly of Crewe—practically but plainly denied it by employing outside cylinder engines with straight axles for all their passenger trains. The London and Brighton Railway Company had about forty so made from the "White Horse of Kent," when Mr. Thomas Kirtley was appointed to the locomotive superintendence of that line, while on its neighbour, the London and Dover, were, I believe, four examples of a compromise; four locomotives with crank axles driven by inside cylinders, but having no wheels on them, coupled to a pair of wheels on straight axle, and these, if I am correct, were especially built by Messrs. Robert Stephenson and Co., of Newcastle-upon-Tyne, to run the tidal express.

R. and W. Hawthorn continued to use the flanged wheel, and though Sharp and Roberts did so also, they brought the flanges to 4ft. 5½in. between and thinned the flange. Of course Bury and Co. could not alter this detail in their four-wheel engines. These may be taken as—with Stephenson, of course—the schools of locomotives in this country, each with some essential feature. I notice a modification of Hawthorn's egg motion illustrated in The Engineer as the new London and North-Western gear.

I may be allowed to mention that the first steel crank axle was made by Mr. William Vickers, of Sheffield, the chairman of the Sheffield and Rotherham Railway, for the "Sheffield" locomotive in 1841, I think. He also tried to connect his wheels, large and small, by proportionate pulleys and gut bands, which contrived to get off on a sharp curve. I am not sure whether Mr. Dodds, of wedge-motion fame, did not in some way assist Mr. Vickers in the trial. Mr. Bury described Stephenson's engines on the London and Birmingham Railway as "four-wheeled engines in disguise;" and it will be wise to consider whether, in the face of the death-rate of, as well as from, cranks and crank axles, it will be best to discard the wheel, or to adopt the outside cylinder.

October 27th. Graduate.

Sir,—Having read with great interest your leading articles, and the varied views of your numerous correspondents, on this most important subject to engineers generally, and especially at the present moment to those engaged in the manufacture of locomotives, we beg leave to say a few words ourselves upon this matter. All, we think, have fallen short in their ideal of what a perfect crank should be. The webs of a forged or block crank are, as is well known, considerably weakened by having the middle of the slab cut away, thus leaving the grain or fibre of the metal across them, at right angles to the stress put upon them by the engine; and although several methods have been used to obviate this weakness, such as piling the slabs in different directions so that the grain of the iron runs in alternate ways, also by hooping the webs, &c., still in actual work the web is the part of the crank which most frequently fails.

Now, we maintain that cranks bent by our patent process—which you illustrated and described in your issue of the 21st June, 1878—this serious defect is entirely overcome. All cranks of our manufacture are bent from a suitably forged bar, which, when placed in the press, has the ends forced inwards at the same time as the throw is formed, and thus the grain or fibre of the material is in no wise disturbed or distressed, but is continued all along the arms and neck, in fact, all round the throw—thus materially strengthening the crank, and not unfrequently making the throw stronger than the other portions. Again, this system requires fewer heats than any other, and the deterioration of the material is reduced to a minimum.

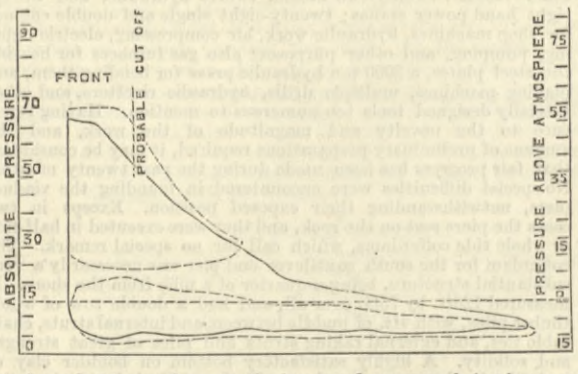
We have locomotive cranks made by our system running under engines on some of the principal lines of railway, which are giving great satisfaction, and which have already exceeded the average lifetime of the block crank. We certainly are of opinion that bent cranks are the cranks of the future, and that their universal adoption is now only a question of time. Certainly, both theoretically and practically, it is the stronger of the two types look at it in what direction you may.

Clarke's Crank Company.
(C. Cousins.)

Lincoln, November 5th.

SIMPLE AND COMPOUND ENGINES.

Sir,—I must thank you for your courtesy in publishing the diagrams asked for. I am sure they will interest many besides myself. Having them and Mr. Longridge's explanation, I can see at once the ratio of expansion is pretty nearly equal for both trials, viz., about six. No one believes that the compound engine, merely as a compound engine, secures the result in economy; but it has made possible, for the comparatively short stroke screw engine, a higher range of expansion than could be practically carried previously, a more equable pressure on the crank pins throughout the stroke, a lightness of parts, the increased pressure being borne on a smaller area, and a rapidity of expansion, none of which are attainable in a single cylinder. Triple expansion will, for similar reasons, in larger sizes no doubt in turn supersede this, and when employed on triple cranks will give steadier motion; while the whole machinery space will be diminished, Joy's, or some similar valve arrangement, being sure to be adopted. I have combined all three diagrams in the accompanying diagram, which will no doubt interest many of your readers.



W. S.

Liverpool, November 5th.

FATAL TRAMWAY ACCIDENTS.

Sir,—I should consider it a great favour if you would kindly allow me some space in your paper for some remarks on the above subject. During the several years I was engaged in superintending steam tramway service, my attention was drawn to the fatal accidents often occurring. Thanks to the ability and great care of my drivers and other workmen, I was fortunate enough in never having a single accident. Guided by the opinion of several tramway managers, and by my own experience, I devised lately an elastic life guard for engines and cars, to shift aside, without injury, persons fallen on the ground. A little calculation will show, if I am not mistaken, that the ordinary guards made of boards or iron bars, sometimes used and claimed for the protection of the public, by the able and humane writer of the article on fatal tramway accidents, in your issue of the 31st October, are as dangerous, if not even more, than if there were no protecting pieces at all.

Assuming, for example, for horse cars, a mean speed of five miles per hour, the weight of a car only half filled with passengers, at 4 tons, the length of the car 20ft.; then the accumulated work W in foot-pounds will be: $W = h\,w$; h = height in feet through which the body falls, = $\frac{w\,v^2}{2g}$; w = weight in pound of body; v = velocity of body in feet per second, = $\frac{8960 \times 7{\cdot}33^2}{64{\cdot}4} = 7475$ foot-pound. Assuming, further, the car stopping in 15ft.; F = force imparted by the accumulated work in pounds; x = distance in feet to which any obstacle is moved by the car; $F = \frac{W}{x} = \frac{7475}{15}$ = 498·3, say 500 foot-pounds force of the blow imparted, which by the application of an elastic guard, will be reduced to a minimum. The writer of the former article is perhaps not aware of the considerable difficulties encountered, and the many conditions to be fulfilled to answer the purpose. There are two diametrically opposed problems to be solved. On the one hand, the apparatus must be as distant as possible from the level of the rails, not to

become a road sweeper; while on the other hand, it must be as close as possible to the rail level to prevent even a child's arm coming near the wheel. I arranged the apparatus therefore accordingly; I also combined with it a rail cleaner, to reduce the tractive power required of the already overworked horses. Each car thus cleans the permanent way, whenever necessary. The muddy state of rails requires, according to experiments, six times the amount of tractive power on clean rails. I am prevented to enter fully into the subject at the present moment not to trespass on the Patent Law, as my final specification was only filed on 31st October last. I shall be glad to show, to any party interested in this question of public benefit, the models I have made, so as perhaps to be enabled to bring the apparatus to practical application.

18, Golden-square, London, H. CONRADI.
November 4th.

SIR,—I am very glad to notice that on page 335 you direct attention to the number of fatal accidents upon tramways, and to the necessity for some form of guards. Four years ago, at the request of the directors and secretary of the Leicester Tramways Company, I tried several forms of iron guards—some fixed to the car frame and others to the axle-boxes; in practice it appeared that all these iron guards, if placed low enough to be of service, were liable to catch the paving stones, and were on some occasions broken off. Fearing that this might lead to an accident, I took off the iron guards and tried a brush fixed exactly on the same principle as the snow brushes used on railways. For three and a-half years every car on the Leicester Tramway has been provided with these safety brushes, and a car is not permitted to run under any circumstances without them. Many cases have occurred of persons and children being either brushed out of the way or pushed forward until the car could be stopped. The plan costs very little, and, of course, is not patented. I therefore mention the fact that such brushes are in satisfactory use, in order that other tramway companies may take the necessary steps to prevent accidents. I quite agree with your remark, that it is nothing less than "criminal negligence" to run cars without proper guards; more especially does this appear to be the case when we consider that brushes have been fitted to every Leicester car for three and a-half years.

CLEMENT E. STRETTON.
40, Saxe Coburg-street, Leicester, November 4th.

TIDAL ACTION.

SIR,—I hope that Mr. Boult will not deny the accuracy of Sir Isaac Newton's statement, that "every substance in the universe attracts every other substance with a force jointly proportional to their mass, and inversely proportional to the square of the distance." If he admits this, then I must refer him to any text-book on physical geography, where he will generally find the origin of the tides explained clearly enough. I would not feel justified in filling your columns with a complete treatise on this subject. The little I said in your issue of October 24th was merely intended to introduce one or two ideas, which appeared to me to be new, and to be consistent with fact.

I did not state that Sir William Siemens made the tides a subject of much study, but he did devise a means by which the depth of the ocean was approximately ascertained, by first observing the speed of the tidal wave over any particular area, and then calculating from this the depth of water there.

I am not beholden to Mr. Russell for the opinion that the altitude of a wave increases with the depth of the water. The converse is my opinion, the reason for which I state in the second paragraph of my letter. Mr. Boult has misapprehended me.

R. SNOWDON.
Widnes Foundry, Widnes, November 5th.

ATLANTIC STEAMERS.

SIR,—Your comparison of the Oregon, America, and Britannic is not accurate in the matter of the speed, indicated horse-power, and consumption of the America. The fastest passage of that ship is 6 days 14 hours 18 min., and the mean speed was 17·82 knots. The mean indicated horse-power for the whole of this voyage was 7368, and the consumption 175 tons per day; so that, as far as the America is concerned, your table should be as follows:—

	Fastest passage.			I.H.P.	Consump.	Tonnage.	Speed.
	Dys.	hrs.	mins.				
S. S. Oregon	6	12	27	12000	265 tons.	7250	18 knots.
,, America	6	14	18	7368	175 ,,	5530	17·82 ,,
,, Britannic	7	12	17	4900	100 ,,	5004	15·8 ,,

It will be seen that the gain on time of the America over the Britannic is 22 hours, and the extra power required to gain this advantage is 50 per cent. If the power required to drive the Britannic at the America's speed be assumed to vary only as low as the cubes of the speeds, the former will require 7029 indicated horse-power, or about 5 per cent. less than the America. As the America's tonnage is 10 per cent. greater than the Britannic's, the comparison between these two vessels is not so unfavourable to the America as you state. If the indicated horse-power vary as a higher power than the cube of the speed—which it is very likely to—the America will appear to still greater advantage. I trust you will see fit to make these corrections. J. H. BILES.
Clydebank, November 3rd.

NEW THAMES BRIDGE AT LITTLE TOWER HILL.

SIR,—Obstruction bridges seem to be the order of the day both on the Thames and others of greater magnitude. Sir Joseph Bazalgette in his report on the Tower Bridge, states that about twenty-four masted vessels per diem pass up and down the river between the Tower and London Bridge. I presume this includes those long river boats which are much used in the summer season. Be that as it may, I do not consider a quarter of an hour a very long period of time for the raising and lowering, or swinging and passing through of a vessel in any of the forms of construction you have elaborated in your last issue, and which would involve a loss of six hours per diem. This seems to be a wonderful improvement for relieving the traffic of the great metropolis. I will not enter on the question of a vessel being stopped in its course before the opening of the bridge. I have a lively recollection of the rapid flow of the river Thames in a spate, and am quite confident that should a stoppage occur for only a few minutes, the vessel would drift broadside on towards the bridge, where it would eventually foul. In the interest of free navigation, as likewise to relieve the traffic of London, let us do nothing in halves. High level bridges are the only remedy—if bridges are desired—although they entail great expense, and probably tend to destroy the amenity of the surroundings. ROB ROY.
November 4th.

THE ROCKET.

SIR,—As bit by bit is added to the history of this celebrated engine, we bid fair to learn the true version, which will be recorded in your columns. I have good reason for believing that the Rocket of the opening had a material alteration from that of the Rainhill trials; for during one of the trips, when Mr. Booth was on it and steam was low, he suggested to George Stephenson the idea of turning the exhaust steam into the chimney, which was done, at once resulting in great advantage. I am of opinion that the present tubular boiler came from the same source. BOILER.
October 27th.

SIR,—I am very much pleased to read the very conclusive letter in yours of the 17th inst. from my old friend, Mr. Robert Stannard. We have known each other intimately many years, and I knew his father was the contractor for the cutting from Oldfield-lane, Eccles, &c., and I also knew Mr. Stannard was on the Hull and Barnsley Railway, but did not give it a thought until I saw his letter. I well recollect, many years ago, Mr. Stannard and I often conversing about the Rocket and the early Liverpool and Manchester Railway. I well recollect seeing at least one locomotive of the Stockton and Darlington type with two vertical cylinders partly let into the top of the boiler, with two marine crossheads and side rods down to crank pins in each wheel. On referring to my father's diary, I find that this would be early in 1830. I recollect seeing this in the cutting near Oldfield-lane Bridge, and as nearly all this material had to be led five or six miles on to Chat Moss, it was just the place where locomotives were required. I find memoranda made at the time of the trial in October, 1829, describing the Rocket fully, and I also find notes made on the 15th September, 1830, referring to the Northumbrian, Meteor, Arrow, Comet, Dart, North Star, Phœnix, and Rocket, and the notes say, "This last is the *identical* engine described in October, 1829." I also find I have a hand sketch made of the Northumbrian in September, 1830, a copy of which I send you herewith. You will see it shows the left-hand side of the engine, and I think it will convince you it is a view of the same engine that your sketch shows in yours of the 12th September by Mr. J. Nasmyth. I find many notes referring to the Rocket after the opening. On November 19th, 1829, I find that the Rocket was going to be sent from the Liverpool end to Mr. Stannard's contract at the Manchester end. On June 19th, 1830, the Arrow first brought the directors through from Liverpool to Salford in two hours, and took them back in one hour thirty-four minutes. On August 28th, 1830, the Rocket, Arrow, and Phœnix brought the directors and a party of friends from Liverpool to Manchester. On November 5th, 1829, the Rocket drew ten times its own weight at 14 miles per hour. I also have a note somewhere, after the opening, of one of the train engines getting off the road by pitching into a coal wagon, and the note says the Rocket took the train on to Manchester. Speaking of early locomotives and the old hand gear, many years ago, one day, an old friend of mine whom I had known from a lad at a stationary winding engine, then as a fireman on the railway, and he soon became engineman, then night foreman, and at the time I speak of he had become the second in command in the locomotive department on one of our leading railways. His railway experience began in 1846, after hand gear had nearly gone out, and the Pow engine, so called by old Lancashire enginemen, in connection with the four excentrics and gab motion. I saw this old friend one day get on an old locomotive with two loose excentrics and hand gear, intending to move it. He tried hard for a long time, but had to give it up. He could not get her to move, when another old friend—Old Bill—who did understand hand gear, got on, and off she went in a jiffey. I have often started a load by hand with Bury's old motion, while the same engine would not start if in gear with the excentrics. You could give the engine the steam, full on the piston, the instant the crank passed the centre—that is if you knew how. The introduction of the reversing lever helped many a man to become engineman who never would with the old hand gear. I can give you a list of some of the early Liverpool and Manchester engines. After the Northumbrian was the Planet, being the first with inside cylinders 11in. diameter and crank axle; Majestic, outside cylinders 11in. diameter; Mercury, inside cylinders; Mars, Samson, 14in. cylinders; Goliath, inside; Jupiter, ditto; Saturn, Sun, Venus, Vulcan, which was the first by Messrs. Murray, Fenton, and Co., of Leeds. I find I have had in my possession and have a good deal of it still, either whole or in parts, of locomotives' motion work, &c., made by Messrs. Stephenson, Melling, Dewrance, Forsight, Grey, Tayleur, Jones and Potts, Timothy Hickworth, Edward Bury, Hawthorn, Sharp, Roberts, and Co.; Fairbairn, Fenton, Murray and Jackson, George England, McConnell, Trevithick, Beyer, Peacock, and Co.; John Ramsbottom, Wilson, of Leeds; Manning and Wardle, Baldwin, of Philadelphia; Crampton's patent, Tulk and Lee, of Whitehaven; Riche's patent, Garforth's, Dukinfield; Kirtley, of Warrington; Stotherd and Slaughter, of Bristol; Cross, of Sutton; Neilson, Gilkes, Wilson, and Co., Middlesbrough; Copely, Middlesbrough; Adams, and many others. I have also had portable engines in my hands by the following makers, Howden, of Boston, Clayton and Shuttleworth, No. 2, of which I still have the name and number plate; Tuxford, Hornsby, Michell, Penistone; Bache, Burton, and Proctor; Robey and Scott, Fowler and Maccollin, and fifty other nondescripts. I have nearly all the traction engines belonging to the Bray's Traction Engine Company, marine engine work and boilers from gunboats of the Spanker class, and from line-of-battle ships, Queen Orlando and others, which were at Sebastopol. I had also a large quantity of the Russian marine work which came from Sebastopol after the war. I had also a great part of the engine motion work which was used in making the Suez Canal. I may say, in conclusion, in reply to a letter signed "X." in yours of the 24th, I thought everybody knew, who takes interest in locomotives, that Mr. Booth was the inventor or suggester of the Rocket's boiler, which was in almost every detail the locomotive boiler of to-day, and there was nothing to prevent Timothy Hackworth's engine doing as well at the trial, in October, 1829, as the Rocket, if she had a fire-box and tubes like the Rocket.

I trust that your readers will now be convinced that the Rocket which took the prize in 1829 was the same Rocket that was at the opening, September 15th, 1830, and that was for some time after on the Liverpool and Manchester Railway, of which I could give further proof, and of which the remains are in South Kensington.

Ashton-under-Lyne, ISAAC W. BOULTON.
October 29th.

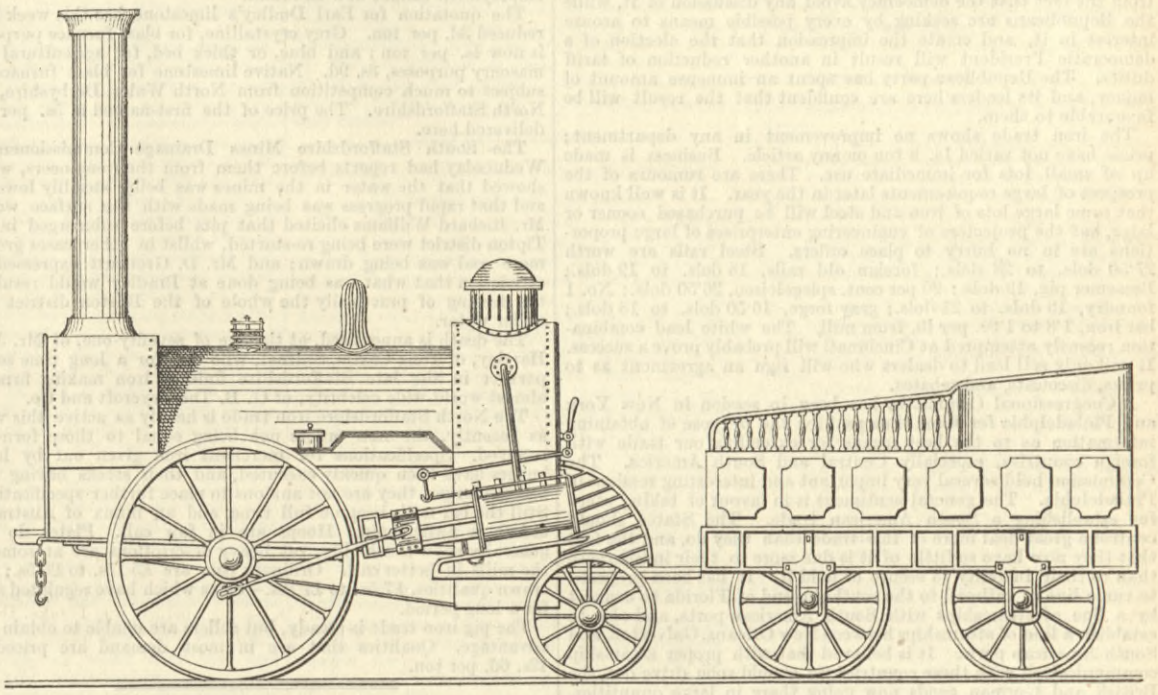
SIR,—There were two engines of this name; one was built for the Swannington Company, but ran for a time on the Liverpool and Manchester Railway. Mr. John Ellis said he would like her name changed to Comet, and one of the old Newcastle workmen well remembers a new name-plate being cast for her, and sent per boat to be fixed on her.

Newcastle-upon-Tyne, OLD FITTER.
November 3rd.

SIR,—Your correspondent "A Leicester and Swannington Man," is all at sea about the two Rockets. The Rocket which opened the Liverpool and Manchester Railway is undoubtedly the engine now at South Kensington, and what your correspondent calls the second Rocket was really the Comet, an engine built shortly after the Rocket, which also took part in the opening of the Liverpool and Manchester line, and was afterwards taken by the driver, David Weatherburn, to open the Leicester and Swannington Railway, and after that worked on the construction of the London and Birmingham Railway. R. STANNARD.
Hull and Barnsley Railway, Howden,
East Yorks, November 4th.

SIR,—Previous to the appearance of Mr. Nasmyth's sketch of the Rocket in your issue of the 12th September last, I never heard or read of two engines of that name in the early history of the Liverpool and Manchester Railway; therefore, I assume that the sketch is the only evidence of the existence of a Rocket essentially different from the, I believe, universally admitted Rocket of 1829, the distinguishing feature of which engine was that the top of the fire-box was some distance below the top of the boiler.

Now, it is not likely that two engines of the same name would be at work at the same time, and I have not the least doubt that the Rocket of 1833, which I assisted in repairing at various times, had a low topped fire-box, and was the only engine with such a fire-box, and was also the only engine of that name then on the line. Under these circumstances it is inconceivable that the sketch represents the Rocket of either 1829 or 1830.



THE NORTHUMBRIAN.

I am, therefore, led to the belief that the sketch represents the Northumbrian class of engine, which class or type intervened between the Rocket of 1829 and the Planet, which was the first locomotive with inside cylinders and a crank axle, and which came out, I think, in 1831. THOS. HUNT.
Gorton Foundry, Manchester,
November 5th.

[Can Mr. Hunt throw any light on the history of the Northumbrian? by whom was the boiler designed? He will see, furthermore, from the letters we publish, that there are still some persons who hold that there were two Rockets.—ED. E.]

SIR,—Will you permit me to sum up the substance of the discussion going on about this engine, with a view to keeping your correspondents to the question at issue?

The matter stands thus, as I understand it: That Rocket certain remnants of which are now in South Kensington Museum took the prize of £500 at the Rainhill trials in 1829. Subsequently it was employed by a contractor engaged in making the railway. By him it was sold, and used on the Leicester and Swannington Railway, opened about 1830. Its subsequent history has been told; but while on the Swannington line, according to some people, its name was changed to Comet, by the desire of Mr. Ellis, the chairman of the line. Notwithstanding this, its identity as *the* Rocket was not lost.

Meanwhile Messrs. Stephenson built seven new engines for working the Manchester and Liverpool Railway. One of these was called the Rocket, and as such was drawn by Mr. Nasmyth, and killed Mr. Huskisson, and would no doubt be identified by the general public as the original Rocket. Thus, then, there were two Rockets running for some time, and the fact that Mr. Hunt has repaired one does not prove that another did not exist.

It is a remarkable fact that all your correspondents who say that Mr. Nasmyth's sketch does not show the Rocket, assert that it does show the Northumbrian. Why the Northumbrian? Why not the North Star, or the Meteor, or any other one of the seven engines present at the opening? An explanation on this point is very desirable. Was the Northumbrian different from the other five engines, to say nothing of the Rocket? I cannot think that any proved statement has yet been adduced to show that Mr. Nasmyth made a mistake. PHILO.
London, November 5th.

APPOINTMENTS OPEN.

SIR,—As many engineers are at present seeking for employment, lists of vacant situations, or lists purporting to be such, readily find readers, but that the distinction I have made exists, the following experience will prove:—

In the number for 1st November of a weekly publication, I read amongst the "Appointments Open":—"6109—civil engineer. 6118—competent draughtsman, surveyor, and leveller. 6119—contractor's engineer. 6120—contractor's engineer." At the head of the column appeared the following:—"On receipt of three penny stamps we will forward the key where to apply for any of the following berths, &c., but this prepayment only covers one address, and must be renewed when two or more applications are desired." I accordingly posted twelve stamps to the editor of the paper, requesting keys to the four numbers already mentioned, and received the subjoined reply:—"Key to 6109—As we have heard the situation is already filled up, we return you 3d. Key to 6118—The Borough Engineer, Nottingham. Key to 6119—P920, ENGINEER Office, 163, Strand, London.—Key to 6120—W. L. C. E., Offices of *Engineering*, 35 and 36, Bedford-street, Strand, London. In your application you should mention the *Engineering Review*."

On receipt of the above, I sent off three applications, enclosing

copies of testimonials. No replies coming to hand, I bethought me that about a fortnight ago I had received a receipt for an advertisement which I had inserted in THE ENGINEER to the effect that a contractor's engineer was disengaged, &c., and that I would again call at the office to see if any letters were there, so I handed in my numbered receipt and received my own application to P920, and on looking at this week's number of *Engineering* found that "W. L." was also advertising himself as disengaged.

Now, the conductor of the *Engineering Review* may think it a good joke to send those seeking employment to others who are doing the same, but next time he inserts in the list an appointment open, and gives as key where to apply for it the number of an advertisement for employment, taken without permission from another paper, he really should endeavour not to refer applicants to themselves.

I enclose my card, together with copies of the papers relating to the above, and hope that by giving publicity to the matter I may prevent others desiring remunerative employment from merely wasting time and money, as in the case of a

2, Howard-street, Arundel-street, Strand, W.C., November 5th.

CONTRACTOR'S ENGINEER.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, October 25th.

A NEW President will be elected one week from Tuesday. The campaign has been rather tame thus far. No issue, except that of the tariff, divides the people, and even that is rather uninteresting from the fact that the democracy avoid any discussion of it, while the Republicans are seeking by every possible means to arouse interest in it, and create the impression that the election of a democratic President will result in another reduction of tariff duties. The Republican party has spent an immense amount of money, and its leaders here are confident that the result will be favourable to them.

The iron trade shows no improvement in any department; prices have not varied 1s. a ton on any article. Business is made up of small lots for immediate use. There are rumours of the prospect of large requirements later in the year. It is well known that some large lots of iron and steel will be purchased sooner or later, but the projectors of engineering enterprises of large proportions are in no hurry to place orders. Steel rails are worth 27·50 dols. to 28 dols.; foreign old rails, 18 dols. to 19 dols.; Bessemer pig, 19 dols.; 20 per cent. spiegeleisen, 26·50 dols.; No. 1 foundry, 19 dols. to 21 dols.; gray forge, 16·50 dols. to 18 dols.; bar iron, 1·8 to 1·9c. per lb. from mill. The white lead combination recently attempted at Cincinnati will probably prove a success. It will only sell lead to dealers who will sign an agreement as to prices, discounts, and rebates.

A Congressional Committee has been in session in New York and Philadelphia for some time past for the purpose of obtaining information as to the best means for extending our trade with foreign countries, especially Central and South America. The Commission held several very important and interesting sessions in Philadelphia. The general sentiment is in favour of taking steps for establishing a South American trade. The States should control a great deal more of this trade than they do, and the fact that they now have so little of it is due more to their indifference than to their inability to secure or hold it. It has been proposed to run a line of railroad to the southern end of Florida to connect by a line of steamships with South American ports, and also to establish a line of steamships between New Orleans, Galveston, and South American ports. It is believed that with proper steamship communication with these countries we should soon drive out the British and German goods now going there in large quantities. Some favour the enactment of commercial treaties. The lack of knowledge as to the requirements of these markets is attributed largely to the inefficiency of American Consuls. The high rates for passenger service charged by the steamship companies has also stood in the way of our trade with South America.

A great deal of interest is being felt in the North as to the coming New Orleans Exposition. There will be about 200 large exhibits from Philadelphia, and as many from this city. The Southern States have contributed from 5000 dols. to 50,000 dols. each for the purpose of making State exhibits. Very large exhibits will be made by the commercial interests of the Mexican, Central and South American States. The Government of the former country has contributed 200,000 dols. for the purpose of making a complete display of the mineral, timber, and agricultural productions of that comparatively unknown country.

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

(*From our own Correspondent.*)

ON 'Change in Birmingham to-day—Thursday—and in Wolverhampton yesterday, new business lacked animation. But finished ironmasters were pretty unanimous in reporting steady deliveries, while in some branches that steadiness increased to considerable briskness. There is not much to complain of, as times go, about the amount of tonnage being turned out; but the leanness of the business is very conspicuous. Shipping orders are cut especially fine; and there seems no help for it so long as trade in other of the producing centres remains tame.

The effect of the postponement of the ironworkers' wages question is rather to discourage than to promote new business in large lots, and buyers will not operate for forward deliveries with freedom. Still, numerous manufacturers are as busy as they care to be at current rates, and the sheet mills in particular keep well off at the prices given a week ago.

Galvanisers are taking increased quantities of sheets to cover orders newly placed for India and Australia; 24 gauge galvanised sheets, bundled, delivered Liverpool, are quoted £12 to £12 10s. for ordinary sorts. The Anglo-American Roofing Company, Wolverhampton, is experiencing an increased call for galvanised shingles for roofing purposes at home, and has this week received an encouraging order for the roofing of a new local Board-school.

The plate mills are running a little more regularly, and some makers have just bought lots of pigs of 1000 to 2000 tons in a line. Tank plates are £7 upwards at the works. Other common plates are £7 10s. to £8, and boiler plates, £8 10s. to £9.

High-class bar iron continues in limited request, chiefly for engineers and Government buyers, but the list price is steadily maintained at £7 10s. to £7. The common bar makers are as well off for orders as they have been at any time during the summer, and prices remain at £6 10s. to £6.

The list of John Bagnall and Sons stands at date as:—Sheets to 20 w.g., £9; 24 w.g., £10 10s.; 27 w.g., £12; ordinary boiler plates, to 5 cwt., £9; best, £10; double best, £11; and treble best, £12. For hoops from 14 to 19 w.g. they ask £8; for angles, fullered shoe bars, and plating bars, £8; and for rivet iron, £9 to £10, according to quality. Their turning and horseshoe bars are £7 10s. The firm's ordinary smithy bars are as here:—1in. to 6in., flat, £7 10s.; 6½in., 7in., 8in., and 9in., flat, £8. Round and square, $\frac{7}{8}$in. to 3in., £7 10s.; 3⅛in., 3¼in., 3⅜in., and 3½in., £8; 3⅝in., 3¾in., 3⅞in., and 4in., £8; 4⅛in. and 4¼in., £8 10s.; 4⅜in. and 4½in., £9; 4⅝in. and 4¾in., £9 10s.; 4⅞in. and 5in., £10. Round only: 5⅛in. and 5¼in., £10 10s.; 5⅜in. and 5½in., £11; 5⅝in. and 5¾in., £11 10s.; 5⅞in. and 6in., £12; 6¼in. and 6½in., £13; 6¾in. and 7in., £14; 7½in. and 7¾in., £15.

The decline in the United States demand for wire rods is a matter of serious moment to the Shropshire makers. These this afternoon referred to the increased buying by America from Germany, and the steadily augmenting supply of her own needs in wire rods by America. The River Plate and Australia are, at date, fair customers for the wire rod mills, but much of the supplies for these countries are still also drawn from the Continent. Screw rods for United States consumption are £7 5s. per ton, delivered in Liverpool.

Mail advices received from Melbourne this week state that when the mail left galvanised iron was in slightly better request. Fair parcels were going off at £19 to £21. Bars and rods were selling quietly at £9 to £9 10s. Sheets had been disposed of at £11 10s. for Nos. 8 to 10; while hoop iron had been quitted at £9 10s. to £10. For fencing wire a slightly better demand had arisen; quotations ranged from £11 10s. to £12 10s.

The native pig iron market is not strong, but users and consumers are taking good consignments on account of the current quarter's contracts. Quotations range for all-mine pigs from £2 17s. 6d. and £3 2s. 6d. to £3 5s. and £3 7s. 6d. per ton; part-mines, £2 5s. to £2 10s.; common iron, £1 17s. 6d., £2, and £2 2s. 6d. Stocks are scarcely so large as they were. The limited production of all-mine pigs should tend to harden quotations, but, as is shown above, there is still a difference of £7 6d. a ton in the selling prices of qualities once supposed to be nearly equal. Makers are not looking for much improvement so long as hematites remain low.

Now that the collieries are again at work supplies of ironworks' coal are in excess of demand, and the Cannock Chase colliery proprietors speak of a considerable falling off in the inquiries. Consequently Cannock Chase prices are easier. The price of Staffordshire furnace, forge, and ordinary household coal ranges between 9s. and 10s. per ton; cobbles, 7s. 6d. to 8s.; best rough slack, 4s. 6d. to 5s. 6d. per ton. The wages of thick coal colliers working at the reduction are 3s. 4d. per day; those of thin coal miners, 2s. 8d. per day. A certain number of men are still out for whom employment cannot now be found.

The quotation for Earl Dudley's limestone has this week been reduced 3d. per ton. Grey crystalline, for blast furnace purposes, is now 4s. per ton; and blue, or thick bed, for agricultural and masonry purposes, 3s. 9d. Native limestone for blast furnaces is subject to much competition from North Wales, Derbyshire, and North Staffordshire. The price of the first-named is 5s. per ton delivered here.

The South Staffordshire Mines Drainage Commissioners on Wednesday had reports before them from their engineers, which showed that the water in the mines was being steadily lowered, and that rapid progress was being made with the surface works. Mr. Richard Williams elicited that pits before submerged in the Tipton district were being re-started, whilst in other cases greatly more coal was being drawn; and Mr. D. Groucutt expressed his conviction that what was being done at Bradley would result in the freeing of practically the whole of the Bilston district now under water.

The death is announced, at the age of seventy-one, of Mr. John Hartley, of Tong Castle, Shifnal, who was for a long time senior partner in the late Staffordshire finished iron making firm, of almost world-wide celebrity, of G. B. Thorneycroft and Co.

The North Staffordshire iron trade is hardly as active this week as recently, the new orders not being equal to those formerly received. Specifications for merchant iron given out by home buyers have been quickly executed, and their stocks having now become larger, they are not anxious to place further specifications. Still the bar mills keep on full time, and an influx of Australian orders is anticipated. Hoops are in fair call. Plates do not generally show much life, yet heavy descriptions are at some of the mills in better call. Ordinary bars are £5 15s. to £6 5s.; and crown qualities, £7 5s. to £7 10s.—rates which have regulated sales for a long period.

The pig iron trade is steady, but sellers are unable to obtain any advantage. Qualities that are in most demand are priced at 42s. 6d. per ton.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Although it cannot be said that there is any improvement in the condition of the iron trade of this district, there appears to be a pretty general conviction that prices are not at all likely to get much lower, and this has tended to give, in a certain sense, a rather more confident tone to the market, which to some extent is backed up by the firmness which is being shown in Scotland and the North of England. Business, however, continues dull, and that the future is not looked forward to very hopefully is indicated by the fact that, notwithstanding a belief that prices have got as nearly as possible to the lowest probable point, both makers and merchants are in many cases open to sell for long forward delivery at present rates. This is a discouraging feature, as it shows that there is little or no anticipation of any early revival in trade that will tend to improve values, and that makers, even at prices which they aver to be unremunerative, are chiefly anxious to secure orders that will keep their works going.

There was a fairly good attendance at the Manchester iron market on Tuesday, but only a slow inquiry was reported generally, and prices for both pig and manufactured iron, so far as they affect this district, were without material alteration from last week. Lancashire pig iron makers are getting small orders, which are sufficient to take away their present output, and they are firm at their late rates of 41s. to 42s., less 2½, for forge and foundry qualities delivered equal to Manchester. For district brands the minimum quoted rates remain at 41s. 6d. to 42s. 6d., less 2½, delivered here, but there are sellers here and there who would take 6d. under these figures to secure business, and at present rates would book orders well over next year. In North-country iron there has not been very much doing here, but large sales of Middlesbrough brands elsewhere have given a firmer tone to prices, and makers are now asking 42s. for forge and 44s. 4d. for foundry, net cash, delivered equal to Manchester. For Scotch iron makers are also asking rather higher prices, but there is only a limited demand in this market.

Although it is only exceptional that manufactured iron makers have any great weight of work ahead, they are in most cases kept tolerably well employed with orders from hand-to-mouth, and maintain their prices at about £5 12s. 6d. for good qualities of bars, £6 to £6 2s. 6d. for hoops, and £7 2s. 6d. to £7 5s. for sheets delivered into the Manchester district. Trade is, however, being very much cut up by the keen competition of merchants, and the market is not as firm as it might be.

I hear that the Lancashire and Yorkshire Railway Company has given out large orders for girder work, which have been secured by two of the leading firms in this district.

The reports as to the condition of employment in the engineering trades are, perhaps, not quite so gloomy as they were a month back, when there was a large and sudden accession of out-of-work members thrown upon the books of the leading engineering trades' union societies, but there is no actual improvement, and the branch statements of the Steam Engine Makers' Society for the month just closed are still of a despondent nature. There is no material increase in the number of members in receipt of out-of-work donation, which remains at about 3 per cent., but no improvement in trade is reported. The state of trade in the marine engineering shops is returned as deplorable. Locomotive firms, with the exception of the railway company's works, some of which are on short time, are still fairly busy, and tool-makers are tolerably well off for work, but engineers' and millwrights' shops vary according to the district in which they are situated, but as a rule they are far from busy or fully engaged.

In the coal trade business has been quieting down considerably during the last week or two, owing to the exceptional mildness of the weather; and although there is no great weight of stock going down, pits are barely being kept going about five days a week. Quoted prices are without material change from last month, and the leading Manchester colliery firms are maintaining their full list rates; but in other districts there has been some giving way upon the October advance, and for special sales prices pretty near as low as those ruling in September are in many cases being taken. At the pit mouth prices average about as under:—Best coal, 9s. to 9s. 6d.; seconds, 7s. up to 8s.; common house fire coals, 6s. to 6s. 6d.; steam and forge coals, 5s. 6d. to 6s.; burgy, 4s. 6d. to 5s.; good slack, 4s.; and common sorts, about 3s. per ton.

The shipping trade continues fairly good, and for delivery at the high level, Liverpool, or the Garston Docks, 8s. 6d. is being got for seconds house coal and 7s. 6d. for steam coal, but there are some inferior qualities offering at 3d. to 6d. under these figures.

Mr. G. C. Greenwell, M. Inst. C.E., who has been elected president of the Manchester Geological Society, in his inaugural address to the members at the monthly meeting on Tuesday, threw out some very pertinent hints with reference to the contribution of papers. He condemned the too prevalent practice of theorising, and urged that more useful results might be attained by the frequent contribution of simply the recorded observations which come under every-day notice. Such contributions as these, whilst they would not tax the members to produce elaborate papers, would tend to practical discussion and the establishment of facts, which would frequently be of more service than long theoretical essays.

At the same meeting a discussion arose on the old question of the effect produced by mine dust on explosions, and Mr. J. S. Martin, inspector of mines, read a report from the German papers of a series of experiments which had been made by a German Government Commission, showing how largely the presence of mine dust contributed to the violence of an explosion. He added that he had received a letter from Mr. Galloway, who had taken a great interest in this subject, and who had just returned from witnessing the above experiments, which fully bore out the conclusions to which Mr. Galloway had long since arrived. The experiments had been made above ground, in a wooden gallery similar in construction, but larger, than the one which Mr. Galloway had used for his experiments. The initial disturbance was effected by firing a shot with ¼ lb. of gunpowder. The results, Mr. Galloway stated, were startling and marvellous. With 20 metres of the floor covered thinly with coal mine dust, and 10 metres of the gallery next to the shot filled with a mixture of one firedamp and twenty air, the flame shot out 185ft. to 190ft. with a noise like the bursting of a magazine, and a train, weighing 12 or 14 cwt., standing on the rails at the mouth of the gallery, was hurled along the rails 52ft., and driven off the metals, the rails being inclined up at an angle of 4 deg. The President remarked that although there might be some doubt as to the precise manner in which the mine dust acted, there was no question whatever that it contributed very seriously to the violence of an explosion, and that the burning of gunpowder, even without the presence of fire-damp, would turn coal dust into an explosive gas.

At the annual meeting of the South Lancashire and Cheshire Coalowners' Association, held at Manchester on Tuesday, Mr. W. S. Barrett, of Liverpool, was unanimously elected president for the ensuing year.

Barrow.—I have to report an improved tone in the Lancashire hematite pig iron trade. Business is a little brisker, and orders from all quarters are coming more freely to hand at higher prices than have ruled lately. It seems to be generally expected that during the coming winter makers will be better employed, and this hope seems likely to be fulfilled. The furnaces in blast are actively working, and the output has by no means been diminished for some time past. Stocks are heavy both at warehouses and at dock sides. The greatest activity is noticeable at the Bessemer department. Forge and foundry samples are not at present much used. A quieter state of things exists in the steel trade, and the flow of orders is checked. The American elections have the tendency of causing fluctuations, but it is expected that when they are decided business will materially improve. I am informed that in anticipation steel rails have gone up 4s. per ton during the past week; it is likely a similar improvement may occur here. An interesting experiment is being tried, I hear, at Barrow. The Steel Company, having several mills at liberty owing to the scarcity of orders, has, at some expense, made alterations in one of them, for the purpose of rolling steel railway sleepers. A small order has been received, and it is to be hoped the experiment may be successful. The demand for hoops and wire has rather fallen off. Shipbuilders are almost unemployed, and few enquiries are being made. Engineers and boiler makers are in reccipt of but few orders. Iron ore quiet at late quotations. Heavy banks of ore are held at mines. Coal and coke does not improve. Shipping dull.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

IT was part of my business this week to make somewhat exhaustive inquiries into the condition of the artisans in the Sheffield district, with a view to find out how many were unemployed. The result of the investigation was this—that there are not many people actually out of employment, but that a very large number are working only three or four days a week for very low wages, and that manufacturers are producing goods at little or no profit. There is a goodly volume of work, but after expenses are paid not much is left in the form of gain on the transaction. The workhouse officials tell me that artisans who used to contribute 1s. a week, or a similar amount, to the support of their parents, now freely beg off on they ground that they earn so little they cannot possibly do more than maintain themselves and their families. In Ecclesall Workhouse, the number of able-bodied men relieved for the week ending November 4th was thirty-two, as compared with the corresponding week of 1883. Of the thirty-two, the cutlery, file, and edge tool trades furnish thirteen, and there are eight labourers. At Tir Vale—the Sheffield township workhouse—there are in the house 679, of whom sixty-four are able-bodied; 409 are from sixteen to sixty years of age, and 270 over sixty. At the corresponding period last year there were 555 men in the house. It is estimated that the average of all classes this year has been about 100 more than last. There are now many more men than women in the house, and they appear to be on the increase. Judging by the mendicants one meets in the street, who state that they are destitute cotton operatives, "We've got no work to do," must be a painfully familiar Lancashire cry just now.

The close of the presidential campaign in America is expected to have a favourable effect on Sheffield trade with the States. Not that the success of one candidate or the other will have much influence in relaxing American tariffs; but the end of the turmoil will admit of business men turning from politics to commerce. It is singular how unsuccessful the Americans have been in their efforts to compete with Sheffield in the production of cutlery. Fourteen years ago one of the largest houses in the American cutlery trade—whose name need not be given here—had no fewer than seventy men engaged in the production of ivory table cutlery alone, and sixty on "rubber"—*i.e.*, black handle—goods. To-day the company has but one man employed half-a-day a week on ivory table cutlery, while the rubber department is entirely shut up. This failure to compete with Sheffield in the finest cutlery goods also applies to secondary classes of table cutlery, as well as to pocket cutlery.

In the razor trade, which has been dull for the United States markets, there is again much briskness for other markets. One or two leading houses are particularly well employed. A large establishment, well known in every country, has on its books orders for over 50,000 dozens, and several others are also well employed. Messrs. George Butler and Co.'s latest speciality in this trade, the keen razor, hollow-ground, has made its mark, and is in animated request.

The German competition with Sheffield hand-forged scissors, which caused no little disquietude at one time, appears to be pretty well played out. The German goods, being stamped from the die, or run into moulds in a fluid state, will not wear very long, and foreign customers are finding this out for themselves. They are therefore gradually going back to the more expensive, but serviceable, hand-forged scissors for which Sheffield has long been celebrated.

Messrs. Mawhood Brothers, manufacturers of axes, &c., inform me that the Government have ordered from America a large number of felling axes, and that five thousand of these are going up the Nile. The pattern is said to be precisely the same as that used by the Premier; and the firm consider it singular, not to say unjust, that the order should go to America; seeing that as far back as 1877 they presented Mr. Gladstone with "one of their original American patent axes," which he declared "possessed all the merits of the original." Messrs. Mawhood say that axes of the American pattern can be made in Sheffield at even lower prices than those charged by the United States makers.

Steel rails, which have been freely ordered of late, are making £4 12s. 6d. to £4 15s. at works, which really does not admit of a profit. Over-production is the cause of the depression, as fifteen firms in England are now engaged in producing what could easily be supplied by five.

The quarterly ivory sales—in which all Sheffield cutlery and other manufactures are deeply interested, comprised 140 tons—against 103 tons at the corresponding period of last year—viz., 58 tons Zanzibar, Bombay, and Mozambique; 3 tons Cape of Good Hope; 30½ tons Egyptian—12½ tons from Alexandria, 18 tons from Malta; 47 tons West Coast of Africa; and 1½ tons cuttings, waste, &c. There were also 4½ tons sea-horse teeth, ¾ ton rhinoceros horns, 3½ tons mammoth teeth, and 1 ton elephants' bones. About 21 tons of the Egyptian and 2½ tons of East Indian were old import, withdrawn from the previous auctions. There was considerable competition, and although prices of all descriptions were somewhat irregular, still the average showed a good result. East India, all large teeth, 70 lb. and upwards, were strongly competed for; medium teeth, 50 lb. and downwards, rather easier; balls, scrivelloes, and pieces steady; but some of the small points, with cut hollows and scrivelloes, sold at less money. Cape was in moderate supply, and sold at full to rather higher rates. Egyptian averaged well in good, large, hard and soft teeth; medium and smaller descriptions lower. A strong demand for West Coast African, notwithstanding the full supply, and all descriptions sold readily. Bangle teeth generally were rather lower for the hard kinds. The stock at 31st October, 1884, is 200 tons, against 160 tons at the corresponding period last year. This is the largest stock since 1879, when there were 213 tons. It is estimated that to secure the quantity needed in the Sheffield trades it is necessary for 12,000 elephants to be killed every year; but this calculation leaves out of account the circumstance that not a little of the ivory is obtained from the tusks which are shed by the noble animal.

THE NORTH OF ENGLAND.

(From our own Correspondent.)

THE Cleveland iron market held at Middlesbrough, on Tuesday last, was well attended. Although the amount of business done was not great, the tone was cheerful and prices were fully maintained. Most of the makers have now sufficient orders to carry them through the present month, and they are not quoting less than 36s. 3d. per ton for No. 3 g.m.b., for early delivery. Consumers and merchants seem willing to pay this figure, and for delivery over the next six months a few purchases have been made at 3d. per ton more. The current price for forge iron is still 34s. per ton. The demand is, however, rather slacker than it was a week ago, and some sellers are willing to accept slightly less.

There is no demand for warrants, although freely offered at 35s. 9d. per ton.

At Middlesbrough Messrs. Connal and Co.'s stock of pig iron was reduced eighty-five tons during the week ending Monday last. At Glasgow the decrease was 530 tons.

No change of any moment is noticeable in the finished iron trade. Messrs. Jones Bros.', rolling mills are at work this week, but it is doubtful whether they will remain so long. Prices are unaltered, ship plates being offered at £5 per ton on trucks at makers' works; common bars at £5 2s. 6d., and angles at £4 15s., all less 2½ per cent. discount. Puddled bars are £3 5s. net.

The steel works in the Middlesbrough district are fairly well off for orders for the time being. The price of steel rails remains at £4 15s. per ton.

Messrs. Suthert and Southorn, of the Cleveland Steel Works, Guisbrough, have booked an order for a large quantity of steel wagon wheels, points, and crossings for tramways in India.

Messrs. Craig and Taylor, of South Stockton, have secured an order for another small iron steamer similar to that commenced last week. It is reported that the Earl of Durham has placed with a shipbuilding firm on the Wear an order for a vessel which will cost about £12,000, that sum being £3000 less than it could have been built for two or three years ago.

Owing, no doubt, to the continuance of fine weather, the shipments of pig iron from the Tees for October amounted to 86,336 tons, being only about 3000 less than during September. The principal items are as follows:—Germany took 24,200 tons; Scotland, 22,120 tons; Holland, 7825 tons; Wales, 6892 tons; France, 5085 tons; and Russia, 3670 tons. Of manufactured iron and steel 26,616 tons were shipped, as against 29,143 tons during September.

The ironmasters' returns for October were published on Tuesday. It appears from them that 98 furnaces were at work, and that 201,187 tons of pig iron of all kinds were produced, being an increase of 4781 tons, as compared with the output for September. Makers' stocks at Middlesbrough have been reduced 5021 tons, but the reduction in the stocks of the whole district is only 174 tons. The total quantity of pig iron in stock at the end of the month was 287,981 tons.

The River Wear Commissioners have accepted the tender of the North-Eastern Marine Engineering Co., Sunderland, for the steel girder work of a new double-ended crane to be used at Roker Pier. The distance from the centre to the extreme ends of the crane will be about 110ft., and it will be capable of lifting 50 tons. The hydraulic machinery connected with it has been ordered of Messrs. John Abbot and Co., of Gateshead.

According to the accountants' certificate, issued in connection with the Durham miners' sliding scale, the average net selling price of coal for the three months ending September 30th was 4s. 8·47d. per ton. The present rate of wages will remain in force.

The arbitration to determine the rate of wages to be paid in the North of England iron trade has been postponed owing to the illness of Mr. Trow, the operative secretary. The standing committee have now decided to extend the award to the end of January instead of the end of November, as originally intended.

This postponement was agreed to by the employers out of consideration for an able and honest official, who, though habitually opposed to them, enjoys their full respect and even hearty esteem. In so doing they have permitted the previous rate of wages to continue for another two months, notwithstanding that it is 2½ per cent. above Dale's scale. Before the arbitration takes place another ascertainment of realised prices will be made and published by the accountant to the Board; and this will, no doubt, justify the second 2½ per cent. reduction they have already claimed.

The employer members of the Northern Wages Board feel somewhat aggrieved at the absence of any disposition to help them by the employers in Staffordshire. The language adopted by the latter towards their operatives at their Board meetings seems to have been characterised of late by weakness and indecision. They have virtually said to them, "We don't want to reduce your wages, and will not do so unless the Northern manufacturers do. If they succeed, which we doubt, then of course we must follow suit; otherwise we are content to let things alone. At all events, we will not take the initiative." In accordance with these ideas the Staffordshire Board has just met, and for the second time postponed consideration of any further reduction of wages till the first week in December. By that time they hope it will be known whether the Northern employers have succeeded in establishing a lower rate of wages or not. Perhaps the most difficult and unpopular part of an employer's business is that of reducing wages, in a falling market, to such levels as will admit of workmen being employed at all. To these affected, and to the ignorant and unthinking, he usually appears as a tyrant, whereas he really is a benefactor. The opposition and unpopularity he has to encounter in doing this necessary work ought to entitle him to the moral support of, at all events, all who are able to look below the surface of things, and especially of those whose experience and duties lie in the same direction. If the Staffordshire employers would confer with their Northern brethren, and arrange with them to claim necessary reductions at the same time and to the same extent, both associations would become much more effective and successful than they are at present. As it is now, the difficult and unpopular work is being done solely by the Northern employers, and other districts simply follow suit. But the Staffordshire employers, by what they say, and what they do, add considerably to the difficulties of the employers on the Northern Board. They enable the northern operatives to contend in their pleadings as follows:—"This reduction is not really necessary. Other districts not more favourably situated than Cleveland do not demand it. In Staffordshire the employers postpone their claim from time to time pending the decision of the Northern Board. They refuse to help you, and manifestly do not believe in the validity of your claims." Every one who knows anything of the present condition of the finished iron trade knows that in no district is it carried on otherwise than at a loss. Lower wages mean continued employment; existing wages mean lessened employment. The arguments of the operatives quoted above are unsound, and if acted on, the result can only be disastrous to all concerned. But they sound plausible, and may have considerable effect upon an arbitrator. It is a pity that the Staffordshire employers should not only shrink from doing their part in helping to lower the cost of production, and in so helping to bring back trade to the country. It is a greater pity that by careless words and timid acts they should add to the difficulties and diminish the chances of success of those who are doing unpleasant, but necessary and useful work, beneficial to districts and populations far beyond their own.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE warrant market was very strong up till nearly the close of last week, but prices have since declined, and fluctuated considerably. No doubt they would have fallen to a greater extent but for the circumstance that the Middlesbrough returns of stock for the past month showed a slight decrease instead of an increase, as had been anticipated. Part of last week's advance, and also of the week's decline, are attributable to difficulties that arose in the iron circle through the failure of an outside operator, who was largely oversold, to square his accounts. The shipments are also considerably lighter than usual, being 8949 tons, as compared with 10,806 in the preceding week and 12,167 in the corresponding week of last year. There is no change in the amount of the production. Some of the ironmasters state that the past month has been one of the best they have had for sales this year. The stock in Messrs. Connal and Co.'s Glasgow stores has been reduced by 315 tons since last report.

Business was done in the warrant market on Friday at 42s. 9d. cash. The market was lifeless on Monday, when prices declined to 42s. 6½d. There was a further fall on Tuesday forenoon to 42s. 4½d., but the afternoon quotation rose to 42s. 6½d. cash. Prices advanced to 43s. 6d. cash, closing at 43s. 4d. on Wednesday. To-day—Thursday—the market was very excited, owing to two additional failures of brokers having been intimated, making four stoppages on 'Change since the beginning of the week. Quotations declined to 42s. 11½d., closing with buyers at 43s. 1d. cash.

The values of makers' pig iron have been very firm within the past few days, and several brands exhibit an increase upon the rates last quoted. Free on board at Glasgow, Gartsherrie, No. 1, is quoted at 55s. 6d.; No. 3, 50s. 6d.; Coltness, 59s. 6d. and 52s. 6d.; Langloan, 58s. and 52s.; Summerlee, 54s. and 47s. 3d.; Calder, 54s. and 47s. 6d.; Carnbroe, 51s. and 47s.; Clyde, 48s. 6d. and 45s. 3d.; Monkland, 44s. and 41s. 3d.; Quarter, 42s. 3d. and 40s. 6d.; Govan, at Broomielaw, 43s. 3d. and 41s. 3d.; Shotts, at Leith, 54s. 6d. and 52s.; Carron, at Grangemouth, 49s.; do., specially selected, 53s. 6d.; No. 3, 48s.; Kinneil, at Bo'ness, 44s. and 43s.; Glengarnock, at Ardrossan, 50s. 6d. and 43s. 3d.; Eglinton, 44s. 3d. and 41s.; Dalmellington, 48s. and 43s. 6d.

The imports of Middlesbrough pigs to date are 221,139, against 229,535 tons in the same period of last year.

There was shipped from Glasgow in the course of the past week four locomotives, valued at £7800, for Calcutta; two at £3400 for Adelaide, and two at £1254 for Bombay; besides £7000 worth of machinery, £4500 sewing machines, £2100 steel goods, and £27,500 general iron manufactures.

It has been found necessary at some of the ironstone pits to reduce the wages of the miners, and in the case of the mines of Messrs. Colin Dunlop and Co., where this has been done, the men have come out on strike.

The shipping trade in coals has now become less active; but this is by no means an unusual occurrence at the present season. During the week there was shipped at the Glasgow General Terminus 17,433 tons, and at the Queen's Docks, 3250 tons; at Ayr, 6450 tons; Troon, 5221 tons; Grangemouth, 6874 tons; and Irvine, 112 tons. The coalmasters have been very anxious to keep up their quotations as long as possible; but, owing to the slow demand for household sorts and for furnace coals, they are finding this no easy matter.

WALES & ADJOINING COUNTIES.

(From our own Correspondent.)

THE result of the agitation in the district amongst coalowners and colliers, with reference to shot firing in collieries, has been the arrangement of a deputation, composed of representative men, to wait upon the Home Secretary. Lord Aberdare was at the head, and he and others interested in the Welsh collieries laid the case very pertinently before Sir W. Harcourt, and their arguments were received with marked attention. From the first, however, it was apparent that Sir W. Harcourt held strong views against shot firing in mines when the colliers are working, and in this view was supported by his inspectors. But he has deferred in some measure to the powerful array of practical opinion brought before him, and consents to arbitration. One suggestion of his was that shot firing should take place between the shifts. This, I am afraid, would not meet the case. Working colliers say that, with proper care, there is no danger in a continuance of present arrangements.

The coal trade was slightly better last week, but it is a long way from being up to late averages. Cardiff, for example, only exported 112,000 tons, as compared with 108,000 of the previous week. Newport and Swansea showed better returns, and but for the gales this week the totals would have been good. Swansea particularly suffers from lack of vessels. Some revivals are taking place in the Rhondda which may be taken as hopeful signs. Bute collieries are working better. Ynysyfeio is restarted, and Mynyddmaio, near Caerphilly, is working again, having been taken by Messrs. Beddoe. In the Merthyr district I have to announce the restart of Abercannaid by the Plymouth Company. Mr. Bailey has shown a good deal of enterprise in the matter, and if a large area of 9ft. extends up to the margin of the town, the speculation will be a good one.

Cyfarthfa collieries have been slack of late, and in all parts of the district I note the increase of small steam coal. In the neigbourhood of pits huge tips are accumulating, and I noticed last week near Neath mounds by the canal, boats having been filled with small and emptied for lack of custom. In Neath district, at Swansea, and Cardiff, I have been much struck with the increase of the timber traffic. Gloucester, when Sharpness Docks were fashioned, made a huge bid for the timber trade; but Gloucester has no 4ft. coal, and dealers find it pay better to bring a cargo of timber in to one of the Welsh ports, as they are tolerably certain of taking a cargo of coal out. From a conversation with a leading timber shipper, I find that Welsh traders are now doing extensively with the Midlands. They have secured the trade up to the point where Liverpool and Hull come into the field.

Swansea Docks were tolerably brisk at my visit a few days ago. The immense dredger, which I inspected, has done good work. Tin-plate in that quarter is only partially good. Prices are drooping, and though sales have been effected of coke plate at 14s. 3d., buyers are forcing them down to 14s., and this, I expect, will be the figure; and at this price stocks will disappear, judging from the orders ready to be put in. Iron and steel are as dull as they can be. It was expected that Treforest Steel Works would have been partially closed, but they are working as from day to day, and so, too, at Cyfarthfa.

From Dowlais to Ebbw Vale there is some degree of expectation, and I hope to be able to announce that some of the colonial rail trade has been secured. I find that the North-Eastern contract of 25,000 tons has gone to Bolckow, Vaughan, and Co., North-Eastern Steel Works, and Darlington. We are still doing a little in Wales for the Colonies and foreign customers. This week several shipments took place, and amongst them one to Buenos Ayres and another to Paysander.

Ore from Bilbao is coming in, but it is a problem whether it pays anybody to ship it. Foreign shippers of pitwood would do well to study the market. There is now superabundance at the ports, and prices are low.

Patent fuel is in good demand; coke limited. Anthracite from Swansea, Burry Port, and Llanelly only moderate; competition between dealers keen, and demand limited.

Government is to be petitioned by leading ratepayers in the Forest of Dean to get the deep "gales" worked; the falling off lately is so great as seriously to affect the rates. Landholders of coal property in Wales might take a wrinkle from this. The four-feet coal is now being worked out rapidly, and coalowners and landlords are satisfied; but what of the deeper measures when the cream has been swept away?

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

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

Applications for Letters Patent.

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

28th October, 1884.

14,217. STOPPERING BOTTLES, H. James and G. Robinson, Sheffield.
14,218. FEED MOTION MECHANISM for ROCK DRILLS, &c., J. Davison, Scotswood.
14,219. GRIP OR HOLDER, T. Kennelly, Birmingham.
14,220. RING SPINNING and DOUBLING FRAMES, J. W. Dawson and H. Simpson, Manchester.
14,221. TIPS for BOOTS or SHOES, F. Parker, Leicester.
14,222. HEARTHRUGS, J. Greenwood and J. Moore, Halifax.
14,223. LOOMS, E. Hollingworth, Halifax.
14,224. LIDS for DRUMS and other PACKAGES, J. Clare, Penketh, near Warrington.
14,225. DYEING BLACK on COTTON, &c., J. Clare, Greenfield.
14,226. STOPPERING BOTTLES, JARS, &c., J. Wilkinson, London.
14,227. BOWS, TIES, and SCARVES, C. A. Brown, Handsworth.
14,228. PLACING EQUAL PRESSURE on ROLLERS of SPINNING MULES, J. Heap, Waterloo, near Liverpool.
14,229. PEDALS for VELOCIPEDES, J. Jackson, Coventry.
14,230. CONTROLLING DAMPER, &c., of STEAM BOILERS, W. Freakley, Longport.
14,231. CURTAIN BANDS, C. H. C. Lowe, London.
14,232. SUBSTITUTION for WREST PINS to STRETCH the CHORDS of PIANOS, J. Vivier and J. Oor, London.
14,233. INDUCTION COILS, J. and E. Hopkinson, London.
14 234. COUPLING, &c., RAILWAY ROLLING STOCK, W. Walton and G. T. Irving, Bishopwearmouth.
14,235. SPRING MECHANISM of TWO-WHEELED VEHICLES, T. Evans, Liverpool.
14,236. SCISSORS, L. Blumfeld.—(*J. Lindner, Wurzburg.*)
14,237. TRAINING HOPS, &c., A. D. Curling, Canterbury.
14,238. EARRINGS, &c., E. W. and T. W. Taylor, Birmingham.
14,239. RENDERING BUILDINGS FIRE-PROOF, H. J. Allison.—(*G. F. Wright and W. C. Dewey, United States.*)
14,240. PREPARING CASEINE, A. M. Clark.—(*E. E. Childs, United States.*)
14,241. COMPOSITION MASTIC, A. M. Clark.—(*A. Denom, United States.*)
14,242 ORNAMENTAL SURFACE for JEWELLERY, &c., J. H. Johnson.—(*J. W. Miller, United States.*)
14,243. VENTILATORS, F. Herbert and H. Osborne, Loudon.
14,244. PRESSURE and VACUUM GAUGES, J. Smith, Glasgow.
14,245. WATER, &c., METERS, S. Hannah, Forest-gate.
12,246. PROPELLING ROWING BOATS, E. Warre and T. W. Salmon, London.
14,247. RACQUET BAT, I. T. Townsend, Coventry.
14,248. PRINTING MACHINES, G. Toulmin and W. Bond, London.
14,249. REFINING SUGAR, J. Nicholas and H. Lafone, London.
14,250. BACKING-OFF MOTION for MULES, T. Knowles, London.
14,251. PULLEYS, M. Le R. Jack, and J. L. Thompson, London.
14,252. PRODUCING STEEL, &c., C. M. Pielsticker.—(*F. C. G. Müller, Prussia.*)
14,253. TIN-PLATE, W. E. Gedge.—(*The Société Générale des Cirages Français, Paris.*)
14,254. STOPPING LEAKAGE in BOILERS, W. Potter, London.
14,255. SCREW PROPELLER BOATS, W. Webb, London.
14,256. HEATING FEED-WATER, T. Lishman, London.
14,257. LAST, H. J. Lane, London.
14,258. STUDS, &c., L. P. Conrad, C. F. Veit, G. Dickman, London.
14,259. PIPES for SMOKING, H. E. Newton.—(*M. T. Wyatt and W. F. Ramsay, Canada.*)
14,260. GAS, A. W. L. Reddie.—(*R. A. Chesebrough, U.S.*)
14,261. WEIGHING BRIDGES, &c., A. F. Link.—(*J. Rademacher, Berlin.*)
14,262. WIND MOTORS, A. Clark.—(*A. Dumont, Paris.*)
14,263. BORING HEADS, J. Dean, J. Smith, and J. Grace, London.
14,264. MANUFACTURING IRON and STEEL, S. Pitt.—(*A. Rollet, St. Etienne.*)
14,265. ROLLING TIRES, W. R. Lake.—(*J. Munton, U.S.*)
14,266. COOKING APPARATUS, W. R. Lake.—(*M. Malkiel, Moscow.*)
14,267. CONTROLLING and CORRECTING TIME, W. F. Gardner, London.
14,268. INVALIDS' and CHILDREN'S BEDS, M. Phillips, London.
14,269. COOKING APPARATUS, W. R. Lake.—(*M. Malkiel, Moscow.*)
14,270. MUSICAL SOUNDING APPARATUS, J. Harrington, London.
14,271. SPRING SEATS, J. Harrington, London.
14,272. CLIPPING SHEARS, W. L. Wise.—(*P. A. Alexandre, Troyes.*)

29th October, 1884.

14,273. SPREADING PLASTIC MATERIALS on FABRICS, R. Walmsley, London.
14,274. CLEANING CANS, &c., H. Smith and A. E. Willdigg, Coventry.
14,275. REFLECTOR for LOBBY and DOOR LAMPS, F. F. Smart, Birmingham.
14,276. DYEING with ANILINE BLACK, W. P. Thompson.—(*A. Descroix, Villefranche.*)
14,277. FEED APPARATUS for GRINDING MILLS, P. V. Gelder, Liverpool.
14,278. PRESERVING COMMODITIES from BECOMING MOULDY, W. H. Barnard, Stroud.
14,279. PORO-ANTISEPTIC SOLES, J. Coates, Dundee.
14,280. BOTTLES and STOPPERS, F. A. Bird and J. B. Fenby, Birmingham.
14,281. HYDROCARBON OIL LAMPS, A. C. Jones.—(*A. Testory, Budapest.*)
14,282. INDIA-RUBBER LINED SAFETY BOAT, J. W. Carmichael and W. Blackwood, Barrow-in-Furness.
14,283. PERAMBULATOR CARRIAGES, W. Rae, Grimsbury.
14,284. BICYCLES, A. J. Blyde, London.
14,285. TANK for MELTING GLASS, E. Brooke, Halifax.
14,286. MULTIPLICATION of COPIES of DRAWINGS, &c., F. B. Michell, Wakefield.
14,287. FILLING and CORKING BOTTLES, C. F. and S. F. Cohen and J. H. Hamilton, London.
14,288. SAFETY ANTI-VACUUM VALVE, H. Swete, Worcester.
14,289. PANS, J. Sundstrom, London.
14,290. PREVENTING NOISE of DOORS, &c., G. E. Chapman, London.
14,291. DISTILLATION of SHALE, T. F. Haldane and W. D. A. Bost, Glasgow.
14,292. COCKS, &c., A. W. Thatcher, Glasgow.
14,293. MECHANICAL GRIPPER, J. Harrower, Glasgow.
14,294. STEAM, &c., ENGINES, D. Joy, London.
14,295. REMOVING NICOTINE, C. A. Wells, London.
14,296. LAYING, &c., WIRES, J. C. Sellars, London.
14,297. WHEELED VEHICLES, J. Foster and J. Wood, London.
14,298. PIPES for SMOKING, W. H. Fox, Bristol.
14,299. TOOTH-POWDER, &c., W. K. Ferguson, London.

14,300. Heating Water, J. P. Blackford, London.
14,301. Pickers for Looms, E. Burslem, Manchester.
14,302. Screw Propeller Shafts, J. P. Wilson, London.
14,303. Compressed Air Engines, A. C. Henderson.—(*J. C. Husson, A. Okolwicz, and J. B. Nonalhier, Paris.*)
14,304. Water-closets, E. Pearson, London.
14,305. Motive Power for Propelling Tricycles, &c., R. S. Wheels, London.
14,306. Cutting Cheese, &c., T. Clarke, London.
14,307. Turbines, &c, W. E. Rich, London.
14,308. Oxide of Iron Pigments, C. Leech, T. Neal, O. M. Lilly, and H. J. Staples, London.
14,309. Multitubular Steam Boilers, F. S. Morris, London.
14,310. Bricks, &c., F. Candy, London.
14,311. Gas Motor Engines, S. Griffin, Bath.
14,312. Clothes Reviver, R. S. Moss, London.
14,313. Window Sashes, J. J. Barton, London.
14,314. Road Carriages, H. J. Haddan.—(*C. Volland, Aillant-sur-Tholon.*)
14,315. Game of Skill, V. C. di Tergolina, London.
14,316. Preparing Wood for Varnishing, &c., R. Willis, London.
14,317. Sweeping Chimneys, E. W. Lay and C. Cescinsky, London.
14,318. Gloves, H. Ashford and J. W. White, London.
14,319. Ventilating Apparatus, E. Banner, London.
14,320. Folding Tricycle, J. Harrington and J. Hopper, London.
14,321. Folding or Collapsible Boats, G. J. T. Barrett, London.
14,322. Decolorising, &c., Tanning Extracts and Liquors, A. M. Clark.—(*J. Sherrière, Lyons.*)
14,323. Reducing Oats into a Mealy Condition, W. R. Lake.—(*S. S. Chisholm, U.S.*)
14,324. Furnaces, P. M. Justice.—(*C. Dietzsch, Malstatt.*)
14,325. Adjustable Stools for Dental, &c., Uses, H. W. Greenfield, London.

30th October, 1884.

14,326. Colouring Matters, I. Levinstein.—(*H. Reinherz, Hanover.*)
14,327. Accurate Adjustment of all Sizes of Pickers and Shuttles, J. and T. Cooke, Hyde.
14,328. Bricks for the Construction of Furnaces, &c., C. Thompson, Sunderland.
14,329. Automatic Safety Door, J. Glaister, Ryton-on-Tyne.
14,330. Pistons for Steam Engine Cylinders, J. Smalley, Liverpool.
14,331. Invalid Writing, &c., Tables, S. C. W. Wallace, Southsea.
14,332. Letting off the Yarn from the Beams of Looms, C. Catlow, Halifax.
14,333. Locomotive Blast Pipe, S. Morley, Stockton-on-Tees.
14,334. Stoppers for Bottles and Jars, W. Smith, Birmingham.
14,335. Holder and Dark Slides to be used for Sensitive Plates, W. G. Honey, Devizes.
14,336. Feeding Sheets of Paper to Printing, &c., Machines, G. A. Wilson, Liverpool.
14,337. Connecting Branch Pipes to Mains, J. Frick, London.
14,338. Treating Old Cotton Waste, H. M. Semmons and V. Nathan, Manchester.
14,339. Scarf Adjuster, C. E. Cotton, Portsmouth.
14,340. Steam Boilers, I. Pimblott, Liverpool.
14,341. Gas Motor Engines, T. Browett, Salford.
14,342. Securing, &c., Railway Carriage Doors, F. W. Webb and E. A. Atkin, Birmingham.
14,343. Playing a New Game of Skill, V. C. di Tergolina, London.
14,344. Shaft Couplings, G. and J. Rushworth, London.
14,345. Washing Machines, T. J. Syer, London.
14,346. Converting Close Fire Ranges into Combined Open and Close Fire, G. and G. Kinnaird, Glasgow.
14,347. Taps or Valves, F. R. Strickland, London.
14,348. Compressible Spring Mattresses, E. A. Tibbatts, London.
14,349. Portable Smoke Uptake, Funnel, &c., T. Oakley, London.
14,350. Releasing Horses, &c., from Vehicles, W. Corbould, London.
14,351. Banana Flour, W. H. Ussher, Bath.
14,352. Securing Elastic Tires or Rings on Wheels, W. Hillman, London.
14,353. Substitute for Ivory, &c., J. Sangster, London.
14,354. Bottle Stoppers, &c., J. Phillips, London.
14,355. Governing Engines, T. R. H. Fisken and C. A. Duvall, East Greenwich.
14,356. Connecting Glass-lined Pipes or Tubes, H. D. Cooper, London.
14,357. Buckles for Harness, H. D. Cooper, London.
14,358. Celluloid, E. Capitaine.—(*Rhenische Hartgummi-Waaren-Fabrik, Mannheim.*)
14,359. Cooking Apparatus, H. W. Hart, London.
14,360. Linings for Garments, W. Jackson, London.—*27th September*, 1884.
14,361. Coating Cartridges, M. Cock, London.
14,362. Parquet Flooring, G. F. Redfern.—(*F. E. Guérin, Paris.*)
14,363. Boots and Shoes, G. Ellard, London.
14,364. Looms, J. Brinton and Co. and T. Greenwood, London.
14,365. Triturators, &c., W. Dawson, London.
14,366. Braces, T. Snowball, London.
14,367. Tidal Weir, W. Webb, London.
14,368. Automatic Flushing Syphons, J. Holroyd and J. Lang, London.
14,369. Removing Stoppers from Bottles, F. J. Beaumont and F. S. Turner, London.
14,370. Oil Lamps, J. E. Hopkinson, London.
14,371. Pintles, G. Hughes, London.
14,372. Mowing Machines, H. L. Hopkins. Chicago.
14,373. Sights for Fire-arms, Lord G. A. Gordon, London.
14,374. Wire Staples, P. A. Newton.—(*O. Peckrun, Dresden.*)
14,375. Elevator Feed Mechanism, A. J. Boult.—(*L. P. Bouvier, Canada.*)
14,376. Wrought Iron Pulleys, R. R. Gubbins, New Cross.
14,377. Electric Signalling, B. J. B. Mills.—(*C. Diener and C. A. Mayrhofer, Vienna.*)
14,378. Printing, G. Hayes, London.
14,379. Explosive Compounds, F. M. Lyte, Putney, and C. L. J. A. Lewall, London.
14,380. Steam Boilers, S. Fox.—(*G. S. Strong, U.S.*)
14,381. Steam Engines, S. Fox.—(*G. S. Strong, U.S.*)
14,382. Valve Gear, S. Fox.—(*G. S. Strong, U.S.*)
14,383. Valve Gear, S. Fox.—(*G. S. Strong, U.S.*)
14,384. Covering for Seats, F. H. Rosher, London.
14,385. Window-sashes, D. Radclyffe, London.
14,386. Slide-valve, C. D. Abel.—(*The Oesterreichisch-Alpine Montangesellschaft, Vienna.*)
14,387. Ornamental Pottery, H. Doulton and J. Slater, London.

October 31st, 1884.

14,388. Cambensy Multifiring Gun, F. Cambensy, London.
14,389. Weighing Silo Pits, H. White, Balla Colla.
14,390. Steam Boilers, G. Stevenson, Glasgow.
14,391. Oscillating Shuttles, J. M. and W. U. Morton and J. Strathern, Glasgow.
14,392. Grater, E. K. Dutton.—(*Alexander Obermeyer, Germany.*)
14,393. Asphalte, J. Stansfield, Fleetwood.
14,394. Stage, &c., Effects, G. Prescott, Dublin.
14,395. Safety Mechanism for Starting, &c., Engines, A. Whalley, Blackburn.
14,396. Connecting Top, &c., Parts of Studs, &c., C. H. Collins, Birmingham.
14,397. Pianoforte Actions, T. Turner, Bristol.
14,398. Fireplaces, G. H. and A. Brown, Derby.
14,399. Automatic Adjustable Railway, &c., Signal Rods, H. M. Wilson, J. Dixon, and M. Waddle, Blyth.
14,400. Double or Sister Hooks, W. O. Walley, Manchester.
14,401. Burglar-proof Safes, W. Beardmore, Glasgow.
14,402. Slicing Sugar Cane, A. Stromberg, London.
14,403. Fans, L. E. White, Chorlton-on-Medlock.
14,404. Teaching, W. R. Warner, Birmingham.
14,405. Teaching, W. R. Warner, Birmingham.
14,406. Photographic Dark-room Lamp, T. C. Hepworth, London.
14,407. Swimming Apparatus, F. Cambensy, London.
14,408. Playing Cricket, &c., T. Cloke and W. A. Ellis, London.
14,409. Wire Ropes, G. R. Cooke, London.
14,410. Road-breaking Machine, G. F. Andrews, London.
14,411. Detachable Pugarees, W. H. Hope, London.
14,412. Preventing Milling Creases in Fabrics, G. Scarborough and H. Stead, Halifax.
14,413. Coal Plates for Cellar Openings, R. H. and J. Pearson, and W. Eyre, London.
14,414. Raising, &c., Table in Leather-dressing Machines, S. Haley, Halifax.
14,415. Tue Iron, J. Taylor, London.
14,416. Arresting Runaway, &c., Horses, W. Stephenson, London.
14,417. Ferrule and Bolster for Chisels, &c., J. Ball, and J. H. and F. P. Rawson, London.
14,418. Lawn-tennis Bats, J. F. Ward, London.
14,419. Binocular Glasses and Telescopes, P. H. Egerton, Wrexham.
14,420. Leg-guards for Football, &c., J. Smallwood, Birmingham.
14,421. Maintaining a Rolled Strip or Ribbon of Consecutively-numbered Tickets in a compact Form while being Reduced in Bulk, J. M. Black, London.
14,422. Tram, &c., Cars, T. Vosper, London.
14,423. Splicing Ropes of Wire, &c., A. Engelmann, London.—*8th April*, 1884.
14,424. Gas Air Warming Apparatus, H. P. Miller, London.
14,425. Elastic Woollen Fabrics, A. A. Halford, London.
14,426. Mill for Crushing Hard Materials, B. J. B. Mills.—(*C. Morel, Grenoble.*)
14,427. Coke Ovens, F. Arnott, London.
14,428. Automatic Sale and Delivery of Cigarettes, N. W. Russ, London.
14,429. Self-adjusting Bearings for Car-axles, H. E. Newton.—(*The Stearns Railway Improvement Company, United States.*)
14,430. Making Imitation Marble, A. B. Joy and J. Lewen, London.
14,431. Locks, G. H. C. Robertson, London.
14,432. Thrall and Tilter for Casks, J. T. Vaughan, London.
14,433. Wood Flooring, &c., A. Putney, London.
14,434. Starting and Stopping Engines, M. W. Bullen, Barnard Castle.
14,435. Harness Buckles, T. W. Hill, Hendon.
14,436. Burners for Oil Lamps, A. Rettich, London.
14,437. Carriage Fittings, J. Edwards, London.
14,438. Tailors' Measure, J. Jacobs.—(*G. Snow, Cape Colony.*)
14,439. Compound Steam Engines, &c., J. T. Dawes, London.
14,440. Additions to Clocks, H. J. Haddan.—(*J. Brandt and G. W. von Nawrocki, Berlin.*)
14,441. Valve Apparatus, E. J. C. Welch, London.
14,442. Preparing Decoctions, E. J. C. Welch, London.
14,443. Carriage Brakes, E. J. C. Welch and W. P. Smith, London.
14,444. Bicycles, &c., W. B. Smith, London.
14,445. Galvanic Batteries, W. R. Lake. —(*F. Kühmaier, Pressburg, and J. Wannieck, Vienna.*)
14,446. Castors, H. Thompson, London.

1st November, 1884.

14,447. Spring Piston Blocks, G. Temple and J. Willis, Sheffield.
14,448. Electric Arc Lamps, G. C. Fricker, Putney.
14,449. Affixing the Stamp of Verification to China, F. J. White, Bristol.
14,450. Weaving Ornamental Fabrics, G. Rowe and J. Walker, Glasgow.
14,451. Corrugated Boiler Furnace Shells,. J. G. Lawrie, Glasgow.
14,452. Cop Winding Machines, T. Kenyon, Blackburn.
14,453. Friction Gear, J. Farrar, E. H. Birley, and T. Dunstan, Barnsley.
14,454. Heel Tip, W. J. Adams, Aston.
14,455. Raising Water, &c., W. P. Thompson.—(*H. Thiery, Paris.*)
14,456. Lamp Reflectors, D. K. Simpson, Liverpool.
14,457. Actinometer, C. Green and L. V. Füidge, Birmingham.
14,458. Hydrocarbon Oil Lamps, J. Sankey, Sutton Coldfield.
14,459. Lubricators, H. Morris.—(*L. Pouget, Montpellier.*)
14,460. Perpetual Motion Machine, T. Stuart, Mount Erris.
14,461. Kettle, C. M. Walker, Dulwich.
14,462. Imitation Swiss Embroidery, &c., B. Hallatt, London.
14,463. After flush for Water-closets, E. L. Stacey, London.
14,464. Weather-tight Water Bars, T. Birch, Wandsworth.
14,465. Metallic Bedsteads, E. Page, Birmingham.
14,466. Hand Grenades for Extinguishing Fires, W. Briggs, London.
14,467. Protecting Soles and Heels of Boots, &c., T. H. Heard, Sheffield.
14,468. Virgin Gas, C. Thompson and C. Hammond, London.
14,469. Making Fluted Metallic Tubes, J. Wilkes, London.
14,470. Repeating Striking Mechanism for Clocks, M. Sultzberger, London.
14,471. Rivetting, C. D. Abel.—(*F. Prasil, Kladno.*)
14,472. Breech-loading Fire-arms, O. Horton, London.
14,473. Railway Brakes, T. Sloan and E. Hawks, London.
14,474. Ripping and Clipping Lappets, &c., J. Marshall, London.
14,475. Looms for Weaving, H. T. Rawlings and T. Moore, London.
14,476. Electric Batteries, E. G. Brewer.—(*J. Cerpaux, Brussels.*)
14,477. Advertising, A. H. Martin, London.
14,478. Purifying Water, F. B. Dœring, London.
14,479. Receptacles for Matches, &c., V. I. H. Bundsen, London.
14,480. Gas Pliers, H. C. Gilchrist and C. Bellamy, London.
14,481. Excentric, &c., Motion for Looms, E. Barlow, Patricroft.
14,482. Wood-planing Machine, J. Peirce, London.
14,483. Pianos and Organs, W. Reynolds, London.
14,484. Casting Flanged Pipes, &c., S. P. Wilding.—(*H. Foersterling, Charlottenburg.*)
14,485. Galvanic Batteries, G. B. de Overbeck.—(*Dr. F. Hornung, Berlin.*)
14,486. Horse-rakes, A. C. Bamlett, London.
14,487. Stoves and Grates, H. Thompson, London.
14,488. Safety Mechanism for Breech-loading Small-arms, F. Beesley, London.
14,489. Compasses and Binnacles, B. Russ, London.

3rd November, 1884.

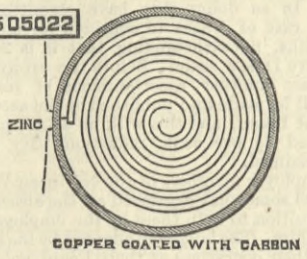
14,490. Forced Combustion in Steam Boilers, A. MacLaine, Belfast.
14,491. Fore-ends of Small-arms, J. Middleton, Birmingham.
14,492. Removing Sandbanks, B. H. Thwaite and B. D. Healey, Liverpool.
14,493. Mechanical Stokers, J. Proctor, Manchester.
14,494. Cigars, W. Watson, Glasgow.
14,495. Detachable Bar Handles for Bicycles, &c., S. Martin, Birmingham.
14,496. Railway Signalling, J. Enright, London.
14,497. Blocks for Clicking, &c., Purposes, H. Branch, Wellingborough.
14,498. Watch Protector, J. Pennington, Liverpool.
14,499. Toasting Bread, W. Kenrick and W. C. W. Panter, Boscastle.
14,500. Stopping, &c., Locomotive, &c., Engines, M. W. Bullen, Durham.

SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

305,022. Self-sustaining Electric Battery, *Wm. Anthony Shaw, Brooklyn.—Filed March 24th*, 1882.

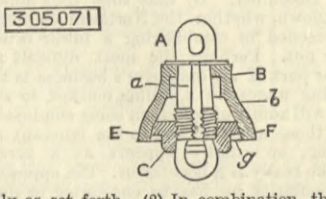
Claim.—(1) An electrode of metal coated with lamp-black, substantially as described. (2) An electrode having a coherent or self-sustaining coating formed by a paste of lamp-black or other carbonaceous powder and sulphuric acid or other battery fluid, substantially as described. (3) A galvanic cell comprising electrodes



of opposite polarity embedded in a mixture of one or more nitrates and absorbent material such as earth, substantially as described. (4) The combination of the carbon coated metal electrode and the opposing electrode with the electrolyte or excitant formed of a mixture of solid salt or salts and absorbent medium, substantially as described.

305,071. Expansion Rubber Bucket for Chain Pumps, *Sanford A. Goss, Chicago, Ill.—Filed October 11th*, 1883.

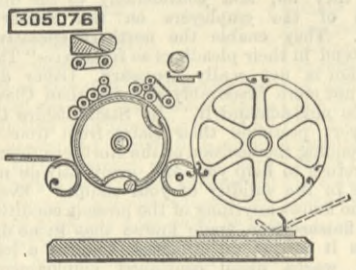
Claim.—(1) In combination, the link A, having projections *a*, the nut C, having bevelled faces E and F, and the bell-shaped rubber B, having slots *b*, substan-



tially as set forth. (2) In combination, the link A, having projections *a*, the nut C, having bevelled faces E and F and squared portions *g*, and the bell-shaped rubber B, having slots *b*, substantially as set forth.

305,076. Printing Machine, *John T. Hawkins, Mass.—Filed November 15th*, 1883.

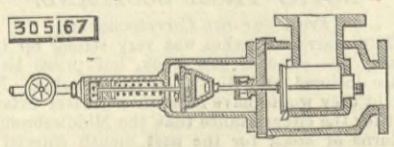
Claim.—(1) In a rotary printing machine, the combination of a plate or forme cylinder, an impression cylinder, and a delivery cylinder or wheels, each of said cylinders carrying a series of grippers for the successive transfer of the sheet from one to the other, substantially as set forth. (2) In a rotary printing machine, the combination of a plate or forme cylinder, an impression cylinder, a delivery cylinder or wheels, and a rotary delivery frame, said frame and each of said cylinders carrying a series of grippers for the successive transfer of the sheet from one to the other,



substantially as set forth. (3) In a printing machine for printing from a forme or plate cylinder, a rotary delivery device consisting of a cylinder or a series of wheels provided with grippers taking the sheet upward from the grippers of the plate or forme cylinder, and a rotary gripper frame carrying one or more series of grippers taking the sheet downward from the grippers of said cylinder or wheels and depositing it, printed side up, upon a receiving board placed beneath said gripper frame without contact of the printed side with any part of the mechanism, substantially as set forth.

305,167. Governor for Pumping Engines, *William Fisher and George H. Beebe, Marshalltown, Iowa.—Filed April 18th*, 1884.

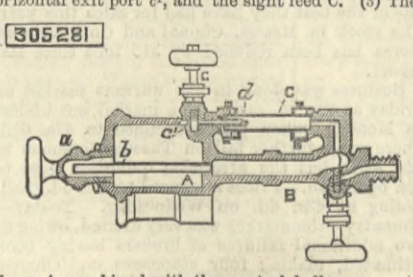
Claim.—(1) In a governor, substantially as described, a double puppet-valve, as B, having bearings of unequal area, arranged as described, a piston G, and spring I, combined with connections between said piston and valve, and with means for subjecting the



piston to the pressure of the street main, and for leading the steam to the valve, as and for the purposes set forth. (2) In a governor, the adjusting means H^1 H^2, in combination with the yoke D, ways A^4, valve B, piston G, spring I, and suitable connecting means arranged to serve as herein specified.

305,281. Sight-feed Lubricator, *William A. Boyden, Jersey City, N.J.—Filed June 28th*, 1884.

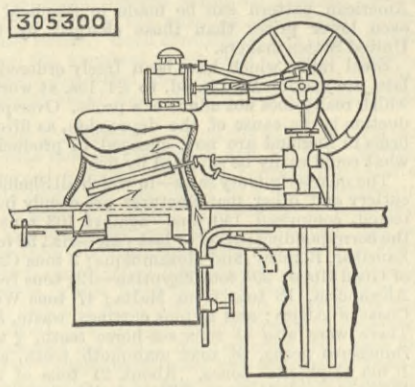
Claim.—(1) The combination of a central steam port opening above the oil, and a horizontal exit port below the oil, with a sight feed, for the purpose as herein set forth. (2) The combination, with a central steam pipe *b*, projecting into the cap *a*, of the central cap *a*, the horizontal exit port c^1, and the sight feed C. (3) The



oil cup A, combined with the central hollow supporting column B, internal upright steam pipe *b*, lower oil-discharge opening c^1, valve *c*, downward extending drip pipe *d*, sight tube C, and an outward extending separate oil discharge pipe g^1, having an independent valve *h*, substantially as herein shown and described.

305,300. Steam Generator, *Jesse P. Forbes, Coshocton, Ohio.—Filed June 12th*, 1884.

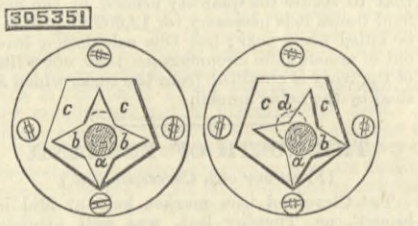
Claim.—(1) The herein described steam generator, consisting of two plates bolted together, and having the generating chamber formed between them, and composed of two wings connected together at their outer ends, and having a water inlet at the inner end of one wing and a steam outlet at the inner end of the other wing, substantially as set forth. (2) The herein described steam generator, consisting of themain plate, having formed in its inner face the double-winged generating chamber, and provided with bolt holes around said chamber and between the wings thereof, and the covering plate placed on the main plate, and having corresponding bolt holes, and the fastening bolt passed through said holes, the said generator being provided with a water inlet at the inner end of one of said wings and a steam discharge at the inner



end of the other wing, substantially as set forth. (3) The combination, with a steam generator having its generating chamber formed with horizontally disposed divided wings connected together, and provided with a water inlet and steam discharge, arranged one at the inner end of each wing, of the lamp having a burner corresponding to and arranged below the said wings, and a division plate arranged between the burners and extended from the lamp to the under side of the generator, whereby the action of each lamp may be confined to the wing under which it is arranged, substantially as set forth. (4) The combination of the hollow stand, the generator arranged therein, and the heater arranged below the generator, the said stand being provided with a cooling or air flue extended above the generator, substantially as set forth.

305,351. Rotary Double Bearing with Periodically Alternate Action, *Herrmann Stange, Dresden, Saxony, Germany.—Filed May 9th*, 1884.

Claim.—The double bearing consisting of the star-formed bearing *b* and the polygon *c*, whereby the inner bearing *b* bears frictionless by means of one of its knife-edges in a corresponding corner or junction of



two sides of the polygonal, and whereby this free bearing produces a periodical alteration in the position of the axis *a* to the axis *d*, in order to produce a limited rotation of the outer layer by the dislocation of the centre of gravity, substantially as described.

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Its Weight in Gold.—The aggregate production of gold, in the United States of America, up to June, 1883, we have just been told on the authority of the *Times*, was 78,965,572 troy ounces. When we saw this particular weight of gold given as the accumulation of all preceding years, we were at once struck with the remarkable approximation of the weight given to what had just come to our knowledge was the output of Cocoa in this Country by one firm (James Epps and Co.) for one year only, the last twelve-month, it being 86,403,333 troy ounces, or 2645 avoirdupois tons, and, on the moment, we could not withstand recalling to mind the old adage—"Worth its Weight in Gold."—[Advt.]