THE FLOW OF WATER IN PIPES.

By Prof. W. C. Unwin.

In reading again recently the paper by Dr. Lampe, on "The Flow of Water in Pipes"—*Civilingenieur*, 1873—the writer noticed the curious fact that Hagen obtained, as early as 1854, a formula identical with that recently given by Professor Osborne Reynolds—*Phil. Trans.* of Royal Society, 1883. Hagen obtained his formula empirically, while Professor Reynolds has arrived at his by reasoning. The coincidence is therefore interesting.

Professor Reynolds' formula simplifies to the form—temperature constant,

$$\frac{h}{l} = m \frac{v^n}{d^{3-n}}$$

where h is the loss of head in a length l; v is the velocity, d the diameter, and m and n constants. The constant n has values ranging from 1·7 for the smoothest to 2 for the roughest surfaces.

If we take $n = 2$, we get the common Chèzy formula

$$\frac{h}{l} = m \frac{v^2}{d}$$

but in most actual cases the index of the velocity to which the resistance is proportional is smaller.

Now Hagen, from experiments on small pipes, obtained the formula—

$$\frac{h}{l} = m \frac{v^{1 \cdot 75}}{d^{1 \cdot 25}}$$

which is obviously identical with Reynolds', with $n = 1 \cdot 75$. Further, it may be noted as interesting that Hagen made experiments at different temperatures, and concluded that the value of m varied with the temperature in a very marked way. For English feet, Hagen's values reduce to

Temperature.	$m =$
32 deg. Fah. . . .	·0002173
212 „ . . .	·0001314

In experiments on the friction of rotating discs, I found a quite similar diminution of the resistance as the temperature increased. Putting M for the moment of resistance of the disc, at N revolutions for a brass disc,

$$M = C\,N^{1 \cdot 85}$$

where C had the following values :—

At 41·2 deg. Fah.	C = 0·122
53·0 deg. „	0·115
70·4 deg. „	0·111
130·5 deg. „	0·100

Dr. Lampe's paper contains the results of experiments which he made on the discharge of the water main at Dantzig. This was a clean cast iron pipe, 16in. in diameter, and with a smooth pitch coating, which appeared uninjured after two years' use. It was 45,000ft. long, and measurements of the loss of head and discharge were carried out with quite exceptional care. The results may therefore be used to test the applicability of Professor Reynolds' formula for practical purposes. Four series of experiments were made, and Dr. Lampe mentions that the measurements in the first series were less trustworthy than in the other three.

Reducing the data in Dr. Lampe's paper to English measures, we get the following formula of Professor Reynolds' form :—

$$\frac{h}{l} = 0 \cdot 0003707 \frac{v^{1 \cdot 85}}{d^{1 \cdot 15}}$$

The following table shows the agreement of the observed and calculated values :—

Diameter of Pipe, 1·373*ft.*

Series.	$\frac{h}{l}$	Velocity.		Discharge.	
		Observed.	Calculated.	Observed.	Calculated.
I.	·001950	3·083	2·987	4·564	4·423
II.	·001630	2 703	2·712	4 002	4·015
III.	·001376	2 474	2 474	3·663	3·663
IV.	·0005915	1·573	1·568	2 329	2·321

The agreement is obviously very close, except in the case of the first and least trustworthy series.

For comparison with his own experiments Dr. Lampe has chosen two sets of D'Arcy's experiments on new asphalted iron pipes. The writer reduced these in a similar way, and as the arithmetic is rather laborious, it may be interesting to put the result on record. The formula will not fit these experiments well unless the constant n is somewhat increased. The following values of the constants are suitable :—

For series XVIII. of D'Arcy—

$$\frac{h}{l} = 0 \cdot 000379 \frac{v^{1 \cdot 95}}{d^{1 \cdot 05}}$$

For series XXII.—

$$\frac{h}{l} = 0 \cdot 000324 \frac{v^{1 \cdot 95}}{d^{1 \cdot 05}}$$

The following table gives the data observed in English measures, and the comparison of these with the results given by these formulæ :—

Series XVIII.—*Diameter of Pipe*, 0·6168*ft.*

Velocity v in ft. per sec.	Virtual slope $\frac{h}{l}$ Observed.	Calculated.
1·631	0·00175	0·00163
2·487	·00368	·00372
3·701	·00805	·00807
4·882	·01340	·01385
6·342	·02250	·02308
8·222	·03810	·03828
14·18	·10980	·11090
16·17	·14591	·14320

Series XXII.—*Diameter of Pipe*, 1·643*ft.*

Velocity v in ft. per sec.	Observed.	Calculated.
2·602	0·00120	0·00124
2·608	0·00125	·00125
3·416	·00210	·00211
3·654	·00230	·00240
3·674	·00260	·00243
3·700	·00250	·00247

The agreement is here again satisfactory, especially if the range of the experiments is considered.

Hence, to sum up. The formula

$$\frac{h}{l} = m \frac{v^n}{d^{3-n}}$$

fits the three series of experiments well, with the following values of the constants :—

	$m =$	$n =$
Dantzig pipe	0·0003707	1·85
Darcy's pipe XVIII.	·000379	1·95
„ „ XXII.	·000324	1·95

The variations of the constants are no greater than might be expected; for since they depend on the roughness of the pipe, we have no right to expect the same values exactly in any two pipes. The difference is even not more than could be explained by possible variation of temperature.

THE WATCH TRIALS AT KEW OBSERVATORY.

By D. Glasgow, jun., Honours Medalist, City and Guilds' of London Institute.

Ever since the time of Dr. Hooke, who, in the motto, "*Ut tensio sic vis*," enunciated the law of isochronism of springs, and Huyghens, the Dutch philosopher, who made contemporary investigations, the branch of their art which has always received the greatest attention of watchmakers is that known as springing and timing; and as this had long only been taught esoterically—and the learners had to pay heavy premiums for being initiated—it has been regarded until quite recently as a trade secret, and guarded accordingly. It may therefore be anticipated that the subject is not generally very well understood, and, before going into the system of rating watches, it will be as well to explain shortly some of the difficulties encountered in bringing them to time.

Whatever a watch is gaining or losing per day is said to be the "rate" of that watch, and if a watch is not gaining or losing more than two seconds daily, and is performing satisfactorily in other respects, no attempt is usually made to reduce that rate, as any interference with that object would probably only produce an equal error in the opposite direction. Although, in the case of pocket watches, a close rate is desirable, with ships' chronometers it is not of so much consequence, as their times are observed and noted every day. There is not, however, any very great difficulty in making watches go either faster or slower, as required—it merely involving a little extra trouble—but it is the variations from the rates which constitute the timer's embarrassment.

The variations with which timers have to deal are:—(1) Those arising from the varying elasticity of the balance spring, due to changes of temperature; (2) those arising from the want of isochronism of the balance spring, in which long and short arcs of vibration are performed in different times; and (3) accelerations and retardations of rates from various causes. From experiments made by the late Astronomer Royal, Sir G. B. Airey, and others, it has been found that a chronometer having a plain brass balance will lose something over six seconds for each increment of 1 deg. Fah. of heat in twenty-four hours, which amounts to nearly 400 seconds in a range of 60 deg. Of this error, about one-fifth is due to the expansion of the balance, and the remainder to the loss of elasticity of the balance spring. Although no such experiments have been published with regard to watches, there is every reason to believe they would show similar results.

Several contrivances were at first tried to neutralise this error, with varying success, until Harrison's invention of the bi-metallic compensation led up to the present form of compensation balance. The compensation balance for a steel spring is composed of a ring of brass and steel, fused together—the brass being on the outside—which is cut through on opposite sides of the diametrical bar. The rim thus forms two bi-metallic arcs which, from the different expansibility of the metals of which they are constituted, curve inward in heat and outward in cold. Each of these laminæ has a number of holes drilled and tapped along it at certain regular intervals, and carries a smaller number of—usually gold—screws, and by placing the screws nearer to or farther from the free ends of the laminæ, a greater or lesser effect is given to the compensation. In timing ships' chronometers in extreme temperatures a further, or secondary, error is found, from the failure of the compensation to accord with the elasticity of the spring over a large range of temperature; but as a secondary compensation is never applied to watches, it will not be necessary to go into that question here. The timer's first care, then, is to adjust the compensation perfectly for different temperatures, which is done by repeated and protracted trials in the oven and refrigerator, by shifting the screws, as aforesaid.

After the first adjustment is effected the watch is timed in the "long and short arcs," it having previously been brought approximately to time so far as "rate" is concerned; and it is here worth noting that the long and short arcs of vibration of a watch in various positions are performed under different conditions to those for which a ship's chronometer is adjusted. In the latter case the long and short arcs of vibration always take place while the chronometer is in the same position, the falling off in the arcs, after the instrument has been going for some time, being due to the weaker impulses through the thickening of the oil which is applied to the train. In this case—the spring being perfectly isochronous—the length of the arcs should make no difference to the time in which they are performed. As a matter of fact, however, it does, and the great difficulty in timing chronometers is found to be to prevent their gaining in the short arcs. In timing, the short arcs are obtained by either taking some of the power off, by letting down the main spring, or putting a brake on one of the arbors in the train. Watches are never timed in this manner, the difference in the arcs of vibration for which they are timed being caused by the greater friction on the pivots of the escapement when they are hanging than when lying, and here the trouble is to get the short arcs fast enough.

It will thus be seen that a theoretically isochronous spring would not be so in practice, but that some further quality is required in order to overcome the resistance due to the extra friction. The process of bringing a watch to time in the various hanging and lying positions is called "timing in positions." The third question embraces the whole construction of the watch and the qualities of the materials of which it is composed.

The institution of the watch rating tests by the Kew Committee of the Royal Society at their observatory has fully justified the expectations of all concerned, in causing greater attention to be paid by manufacturers to adjustment, and creating a demand among the public for more accurate timekeepers. The unquestionably impartial standard of accuracy thus provided has also acted as a stimulus to purchasers, and manifestly improved the condition of the trade since the establishment of the trials, the undoubted value of the certificates granted being acknowledged on all sides. Watch rating tests have for many years been in operation in Switzerland—at Geneva and Neuchatel—under the directorships of Colonel Gautier and Dr. Hirsch respectively, and for the last five years at Yale College Observatory, U.S.A., under the direction of Dr. Leonard Waldo, and much of the progress that has of late years been made on the Continent in accurate timekeeping is to be attributed to these trials. In Switzerland, in particular, the construction of watches specially for observatory trials has been reduced to an art in itself. But there is a danger in this of running into extremes. At Greenwich, for example, it is well known that the majority of the chronometers which attain a high position on the list would not be fit to withstand the rough treatment of actual use; whereas a chronometer which would perform in every respect satisfactorily on board ship, would not have a chance under the abnormal conditions in which they are there tried. And the same would apply to watches if these trials were to be made competitive. The comparatively short period of the trials renders it possible to construct watches which would give results quite unattainable by watches made to perform well under ordinary conditions, and for long periods together.

A consideration of the following will make these remarks understood. Any escapement may be made so close in its parts and intersections that the least speck of dust or thickening of the oil will cause it to stop altogether; and yet such an escapement would act better for a short time than a more loosely constructed one in which such contingencies are allowed for. As the watches under trial are not subjected to the jolts and movements of ordinary wear—although there has been something said of constructing a machine for that purpose—thinner pivots could be made to the escapement, which would lessen the difference in the amount of friction between the hanging and lying positions. The ratchet toothed escape-wheel of an English watch necessitates a larger amount of "drop"—*i.e.*, the distance between the corners of the pallets and the tooth coming into action—which interferes to some extent with the smooth action of the escapement—than the club-toothed wheel common to the Swiss and American lever watches. But an escapement with the former wheel will give better results in the long run than one with the latter on account of the thickening of the oil, which is almost sure to take place after a watch has been going for some time. The lever and pallets of the Swiss straight line escapement are easier poised, which insures the same conditions in the hanging "pendant right" and "pendant left" positions; and from the relative positions of its parts the difference of side shake in the holes does not affect the intersections to so great an extent; and yet this escapement will not give greater satisfaction under the usual conditions than the ordinary lever escapement.

Besides these points, there are various modifications which might be made of the "lift," "draw," &c., to render the action lighter, but which would not be safe in practice. But the great danger to be avoided is that of manipulating the balance and springs, as putting the former out of poise, &c., and other timers' devices, for the sake of lessening the error in the hanging and quarter positions, which would effectually prevent any lengthened good performance of a watch. A corroboration of these remarks is shown further on in the rates of the watches tried at Kew and Geneva. It will be seen that although the former show less variation from their rates, the latter have the advantage in the position tests. These considerations show that unless the spirit of rivalry, which is, under certain conditions, sure to enter into a competition of this kind, be kept out, these trials may not prove the unmitigated benefit they should, either to the public or the trade. If the Kew tests had been continued on the original lines of giving certificates to all watches performing within certain limits, without further distinction than is afforded by those certificates, it would have been well; but the recent introduction of a system of assigning marks will, it is to be feared, introduce evils similar to those cited.

The following are the conditions of the tests, &c., at Kew Observatory:—(1) The watches may be delivered either at Kew; to the secretary of the Horological Institute, Northampton-square, E.C.; or to Mr. R. Strachan, at the Meteorological Office, 116, Victoria-street, Westminster, S.W. All risks attending their transit and safe custody must be borne by the sender of the watches. (2) Three classes of certificates, A, B, and C, are issued with watches which pass a satisfactory trial. Watches entered for certificate under Class A must remain going at the Observatory not less than eight weeks; for certificates under Class B, not less than six weeks; and for certificates under Class C, not less than three weeks. (3) Persons sending watches for trial must state on a form of entry, which will be supplied on application, the class, or classes, under which they desire to have them tested. (4) The watches are handled by trained observers only, and are not opened nor tampered with. If a movement should stop, the watch is returned to the sender with an appropriate memorandum. (5) All watches are wound when received at the Observatory. If they have run down, the rating is not commenced until they have been going again for five days. (6) The fee for rating and issuing a certificate and abstract of results during trial for each watch is payable on the notification that a certificate is ready to be issued for it. Fee for a certificate of Class A, £1 1s.; ditto ditto Class B, 10s. 6d.; ditto ditto Class C, 5s. 6d. (7) The fee charged for a watch that fails to obtain a certificate is half that for the class under which it has been entered. The statement of its performance is in that case supplied, and if the watch has merited a certificate of a lower class, that certificate is also given.

Certificates are granted to watches as follows:—A: To those which have undergone forty-five days' test, as specified in the details of trials, and whose performance is such that (1) the mean difference of daily rate, under the same conditions of position and temperature, has in no instance exceeded two seconds during the period of trial. (2) The mean daily rate in a vertical position has differed from the mean daily rate in a horizontal position by less than five seconds, and from that in any other position by less than ten seconds. (3) The mean daily rate has been affected by change of temperature to an amount less than one-third of a second per 1 deg. Fah., which is about one-half a second per 1 deg. Cent. The words "especially good" are attached to the certificate when the difference described in (1) has in no case exceeded 0·75 second, when the differences described in (2) have been less than 2·5 and 5 seconds respectively, and when the alteration of rate described in (3) has been less than 0·15 second per 1 deg. Fah. or 0·2 second per 1 deg. Cent. B: To those which have undergone thirty-one days' test, as specified below, and whose performance is such that—(1) The mean difference of daily rate, under the same conditions of position and temperature, has in no instance exceeded two seconds during the period of trial. (2) The mean daily rate in a vertical position has differed from the mean daily rate in a horizontal position by less than ten seconds. (3) The mean daily rate has been affected by change of temperature to an amount less than one-third of a second per 1 deg. Fah. The words "especially good" are attached to the certificate when the difference described in (1) has in no case exceeded 0·75 second, when the difference described in (2) has been less than five seconds, and when the alteration of rate described in (3) has been less than 0·2 second per 1 deg. Fah. C: To those which have undergone sixteen days' test, as specified below, and whose performance is such that:—(1) The mean difference of daily rate under the same conditions of position and temperature has in no instance exceeded two seconds during the period of trial. (2) The mean daily rate in a vertical position has differed from the mean daily rate in a horizontal position by less than ten seconds. The words "especially good" are attached to the certificate when the difference described in (1) has been less than 0·75 second and when the difference described in (2) has been less than five seconds.

The following are the details of trials to which the watches are submitted during rating:—

Class A.—The trial of a watch entered for a certificate in Class A occupies forty-five days, divided into eight periods of five days each, and four intermediate and extra days, during which the watch is not rated. First period: Watch hanging in vertical position, with its pendant up, at the ordinary temperature of the room. Second period: Watch in vertical position, with its pendant to the right, at the ordinary temperature of the room. Third period: Watch in vertical position, with its pendant to the left, at the ordinary temperature of the room. Fourth period: Watch in horizontal position, with dial up, in the refrigerator, at a temperature of about 40 deg. Fah. (30 deg. Cent.) Fifth period: Watch in horizontal position, with dial up, at the ordinary temperature of the room. Sixth period: Watch in horizontal position, with dial up, in the oven, at a temperature of about 85 deg. Fah. (30 deg. Cent.) Seventh period: Watch in horizontal position, with dial down, at the ordinary temperature of the room. Eighth period: Same as the first, watch hanging in vertical position, with pendant up, at the ordinary temperature of the room. The intermediate and extra days, during which the watch is not rated, are at the commencement of the fourth, fifth, sixth, and seventh periods, which are extended one day each for that purpose, the first day's rate not being taken into consideration.

Class B.—The trial of a watch entered for a certificate in Class B occupies thirty one days, divided into five periods, of which the fourth is an intermediate and extra day. First period: Watch hanging in vertical position, at the ordinary temperature of the room, for fourteen days. Second period: Watch in horizontal position, with dial up, at the ordinary temperature of the room, for fourteen days. Third period: Watch in horizontal position, with dial up, in the refrigerator, at a temperature of about 40 deg. Fah. for one day. Fourth period: Watch in horizontal position at the ordinary temperature of the room, for one day, during which its rate is not taken. Fifth period: Watch in horizontal position, with dial up, in the oven at a temperature of about 85 deg. Fah. for one day.

Class C. The trial of a watch entered for a certificate in Class C occupies sixteen days, divided into two periods of eight days each. First period: as in Class B. Second period: as in Class B. The form of trial and the conditions under which the certificates are granted were drawn up by the Kew Committee, after consultation with the Director of the Geneva Observatory, and the Director of the Observatory of the Yale College, U. S. A., at both of which places a similar system is in operation. The Kew certificates have therefore the same meaning, or nearly so, as those of Geneva or Yale. The whole of the arrangements connected with the tests are under the direct management of Mr. G. M. Whipple, the Superintendent of the Observatory. The rates of the watches are ascertained by means of comparison with the mean time of three standard regulators. In order to avoid the possible consequences of sympathetic pendulous vibrations, the watches when tried in vertical positions are placed in the suitable divisions of a shallow drawer or tray, and wedged with pieces of cork. As this appears to be an original idea on the part of the Superintendent, it is worth noting.

By the courtesy of Mr. Whipple I am enabled to give the following further particulars, among which are some extracts from tables, &c., from a paper read by him before the members of the British Association, and which has not been published since it has been revised. The proposal that the system and regulations in practice at Geneva should be adopted and made international emanated from Dr. Waldo, of Yale. It was favourably received by the Kew Committee, and, as the schemes now adopted in Geneva, Yale, and Kew, are identical, a comparison of the results will be somewhat more reliable than estimates based on statistics usually are. The Observatory has had about eighteen months' experience in testing, and is now able to give an abstract of results which will enable those interested to form an idea of the degree of accuracy now attainable in first-class watches. When the trials were first started, the large number of worn and dirty watches which were received from the public caused a great many rejections. The majority of the watches now received, however, are quite new, and come direct from the makers, and from such as these the table of values is derived, the following synopsis of which gives a general view of the working of the system and the deductions from similar tables of the trials at Geneva and Neuchâtel will enable a contrast to be formed of the results:—

Kew Watch Trials.

EXTRAORDINARY GOOD.—A.

Registered number.	Spring.	Mean daily rate.	Mean daily variation.	Variation for 1 deg. Fah.	Difference between pendant up and dial up.	Difference between pendant up and pendant right.	Difference between pendant up and pendant left.	Difference between dial up and dial down.	Difference between extremes of rates.
161	Over-coil.	+3·7	0·4	0·05	+2·0	+3·5	−4·4	+2·5	10·5
162	"	+0·5	0·5	0·06	+1·1	+0·7	−1·8	+2·4	7·5
165	"	+0·3	0·5	0·14	+1·0	+2·0	+2·7	−1·7	8·0
169	"	−1·9	0·4	0·04	−1·2	−0·1	−1·5	+2·0	4·75
212	"	+0·4	0·4	0·07	−0·8	−2·4	+0·1	−4·1	7·0

Taking the 5 watches in the above table, 0·44 represents the mean daily variation of rate, 1·780 the mean variation in positions, 0·072 the compensation error per degree of temperature Fah.

Of 81 watches in Class A, 0·681 sec. represents the mean daily variation of rate; 0·113 sec. represents the compensation error; 2·085 sec. represents the mean variation in positions.

Of 43 in Class B, 1·070 sec. represents the mean daily variation of rate; 0·153 sec. represents the compensation error; 5·315 sec. represents the variation from hanging to lying.

Of 4 in Class C, 0·675 sec. represents the mean daily variation of rate; 3·250 sec. represents the variation from hanging to lying.

Geneva watch trials.—During 1882, 484 watches were tried—208 in Class A, 50 in Class B, and 226 in Class C. In Class A only 13 failed to perform within the conditions, 117 went extraordinarily well, and the remaining 78 performed within the limits.

Taking the 117 "extraordinary good" ones, 0·470 sec. represents the mean daily variation of rate; 1·742 sec. represents the mean variation in positions; 0·063 sec. represents the compensation error.

Of the remaining 78 in Class A, 0·757 sec. represents the mean daily variation of rate; 3·441 sec. represents the mean variation in positions; 0·121 sec. represents the compensation error.

Of the 50 in Class B, 4 were rejected and 29 obtained "extraordinary good" rate papers. Of these, 0·495 sec. represents the mean daily variation of rate; 1·830 sec. represents the variation from hanging to lying; 0·058 sec. represents the compensation error per degree of Fahrenheit.

Of the remaining 17 in Class B, 0·846 sec. represents the mean daily variation of rate; 4·797 sec. represents the variation from hanging to lying; 0·096 sec. represents the compensation error.

Of 226 in Class C, 17 were rejected, and 129 obtained "extraordinary good" rate papers. Of these, 0·516 sec. represents the mean daily variation of rate; 1·790 sec. represents the variation from hanging to lying.

Of the remaining 80 in Class C, 0·934 sec. represents the mean daily variation of rate; 4·341 sec. represents the variation from hanging to lying.

Neuchâtel watch trials.—During 1882, 306 watches were tried. Taking the 30 with first-class certificates, 0·48 sec. represents the mean daily variation of rate; of the 114 with second-class certificates, 0·52 sec. represents the mean daily variation of rate; of the 90 with third-class certificates, 0·57 sec. represents the mean daily variation of rate. At Kew the number of failures to obtain certificates are in percentage as follows, and are thus distributed:—15 per cent. for variations of rate; 6 per cent. for variations due to position; 0·5 per cent. for imperfect temperature compensation; 4 per cent. for other causes.

The analysis of the Kew tables should be very satisfactory to English watchmakers, as, although the results shown are those of the first year's trials, they are higher than those of the Swiss trials, which have been established so many years.

THE PROPERTIES OF GASEOUS EXPLOSIVE MIXTURES.

ABSTRACTED AND TRANSLATED BY B. H. THWAITE.

NO. III.

ISOMERIC MIXTURES.

THE measurement of the pressures developed by a same gaseous system, taken under two primary conditions of density, and to which a similar quantity of heat is communicated, is of the greatest thermo-dynamic importance. If the pressures vary in the same ratios as the densities we shall be justified in concluding independently of all special hypothesis upon the laws of gases: (1) That the specific heat of the system is independent of its density—that is to say, of the initial pressure, and entirely depends upon the absolute temperature, whatever the definition of this may be. (2) That the relative variation of the pressures at constant volume, produced by the introduction of determined quantity of heat, is also solely independent of the pressure and function only of the temperature. Finally, the pressure alone will vary proportionally to the absolute temperature, defined in this instance by the theory of perfect gases, and which it may be able to determine.

Direct measurements would almost be impracticable at the high temperatures, if one had not resource to explosive mixtures. Direct experiment made with an identical gaseous system, but taken under two different and unequal densities, would have been very difficult with the apparatus available; the difficulty was overcome by two artifices—one consisted in operating with a sphere (bombe), one part of which was maintained at the ordinary atmospheric temperature, and the other part was heated in a bath of oil at a temperature of about 153 deg. Cent.; this diminished the density of the gas in the ratio of as 426 is to 293, or about a third. The other artifice consisted in operating upon isomeric mixtures, *i.e.*, collecting the same elements, diversely combined primarily, or at the beginning of the experiment, but terminating in a chemically similar state or condition.

The first method is the simplest and most direct, but less exact. The condition of a cylinder or a sphere—which is cooled in the midst of a bath of oil—being very different from what it would be if cooled in the air.

The experiment made with the oxyhydric $H^2 + O^2$ at 20 deg. and at 153 deg. has given, for the pressure ratios (on taking into account the additional heat necessary to raise the gas to 153 deg.)

$$\frac{H}{H'} = 0{\cdot}74,$$

the ratio of the densities being

$$\frac{\Delta}{\Delta'} = 0{\cdot}64.$$

With a mixture of hydrogen and nitrogen protoxide $H^2 + N^2O^2$ at 20 deg. and at 154 deg., the ratio of the pressures has been found to be

$$\frac{H}{H'} = 0{\cdot}72$$

that of the densities—

$$\frac{\Delta}{\Delta'} = 0{\cdot}64$$

Here the concordance is also as near as one might expect from experiments carried out under such varying conditions. The second procedure, based upon isomeric mixtures, provides more certain data, because the conditions of cooling or lowering of temperature are identical or parallel, always occurring in contact with the air and at the surrounding temperature.

I.—ISOMERIC MIXTURES OF UNEQUAL DENSITY DISENGAGING THE SAME QUANTITY OF HEAT.

Δ representing the densities, and V being the molecular volume, let us place $V = \frac{1}{\Delta}$.

P = the pressure developed in atmospheres, Q = the observed heat in calories. According to the laws of Marriote and Gay-Lussac we should have—

$$\frac{P}{P'} = \frac{V'}{V} \frac{1 + x\frac{Q}{C}}{1 + x\frac{Q'}{C'}}$$

C and C^1 being the specific heats of the two systems at constant volume. The foregoing expressions can be reduced, for high temperatures, to the following:—

$$\frac{P}{P'} = \frac{V^1}{V} \frac{Q}{Q^1} \times \frac{C^1}{C}$$

The following table gives the figures actually observed:—

First System.—Methylic Ether.

Composition.	V	Q Calories.	P Atmospheres.
$2\,C^2 O^2 + 3\,H^2 + O^{10}$ ...	30 ...	312·1 ...	9·9
$C^4 H^6 O^2 + O^{12}$	16 ...	314·7 ...	19·9

We have thus—

$$\frac{P'}{P} = 2{\cdot}0$$

$$\frac{V}{V'} = 1{\cdot}9$$

The density being double, so is the pressure. Besides this, the combustions operating with same velocity, the time elapsed up to the maximum pressure has been found to be—

	Seconds.
For the first mixture	0·00139
For the second mixture	0·00142

Thus the specific heats are sensibly the same. A calculation, based upon the ordinary laws of gases, actually gives for the specific heats—

First mixture...	94·7
Second mixture	89·1

Second System.—Formene.

	V	Q	P
$C^2 O^2 + 2\,H^2 + O^6$	18 ...	185·4 ...	10·0
$C^2 H^4 + O^8$	12 ...	198·5 ...	16·4

We have thus—

$$\frac{P'}{P} = 1{\cdot}64$$

$$\frac{V}{V'} = 1{\cdot}50$$

For the specific heats we have at a temperature of 3305 deg. = 56·1 specific heat for first mixture; for the second mixture at 3303 deg. = 58·6, or practically the same.

Third System.—Methyl.

	V	Q	P
$C^4 H^4 + H^2 + O^{14}$	22 ...	380·1 ...	14·3
$C^4 H^6 + O^{14}$	18 ...	359·6 ...	16·2

We have thus—

$$\frac{P'}{P} = 1{\cdot}13$$

$$\frac{V}{V'} = 1{\cdot}22$$

The loss of quantities of heat is in this instance noteworthy, and tends to compensate for the densities.

A proportional correction will alter the ratio of the pressures to 1·19, that of the volumes being 1·22.

II.—ISOMERIC MIXTURES OF THE SAME DENSITY DISENGAGING UNEQUAL QUANTITIES OF HEAT.

The examination of this second group of mixtures will show the influence of the temperature upon the specific heat.

Third System—Cyanogen and various Comburants.

	V	Q	P
$C^4 N^2 + O^8 + 2 N^2$	20	262·5	14·74
$C^4 N^2 + 4 N O^2$	20	348·9	16·92

We have thus

$$\frac{P'}{P} = 1{\cdot}15$$
$$\frac{Q'}{Q} = 1{\cdot}33$$

The inequality is here very marked, and is increased to a sixth.

The result is that the specific heat of the product increases with the heat disengaged, or with the temperature, the ratio

$$\frac{C'}{C} = 1{\cdot}16$$

Fourth System—Cyanogen.

	V	Q	P
$2 C^2 O^2 + 2 N^2 O^2$	16	172·2	13·6 about.
$C^4 N^2 + N^2 + O^3$	16	262·5	17·7 „

We have thus

$$\frac{P'}{P} = 1{\cdot}30$$
$$\frac{Q'}{Q} = 1{\cdot}53$$

The degree of inequality surpasses a sixth, the specific heat increases with the heat disengaged, the ratio

$$\frac{C'}{C} = 1{\cdot}18$$

Thus the apparent specific heat of the final system increases with the temperature, whilst it does not vary with the density.

Let us proceed with the examinations with gaseous mixtures where the two data vary at the same time.

III.—THOSE ISOMERIC MIXTURES IN WHICH THE DENSITY AND THE QUANTITY OF HEAT VARIES.

Fifth System—Hydrogen and various Comburants.

	V	Q	P
$H^2 + N^2 + O^2$	10	58·7	8·75
$H^2 + N^2 O^2$	8	79·6	13·6

We have then

$$\frac{P'}{P} = 1{\cdot}55$$
$$\frac{V}{V'} = 1{\cdot}25$$
$$\frac{Q'}{Q} = 1{\cdot}36$$
$$\frac{C'}{C} = 1{\cdot}09$$

The specific heat increases with the quantities of heat disengaged or with the temperature.

Sixth System—Hydrogen and Nitrogen Protoxide.

	V	Q	P
$H^2 + O^2 + 2 N^2$	14	58·7	7·94
$H^2 + N^2 + N^2 O^2$	12	79·6	11·08

We have thus

$$\frac{P'}{P} = 1{\cdot}40$$
$$\frac{V}{V'} = 1{\cdot}17$$
$$\frac{Q'}{Q} = 1{\cdot}36$$
$$\frac{C'}{C} = 1{\cdot}13$$

Seventh System—Cyanogen.

	V	Q	P
$2 C^2 O^2 + N^2 + O^4$	16	136·0	9·3
$C^4 N^2 + O^8$	12	262·5	20·96

We have thus

$$\frac{P'}{P} = 2{\cdot}25$$
$$\frac{V}{V''} = 1{\cdot}33$$
$$\frac{Q'}{Q} = 1{\cdot}93$$
$$\frac{C'}{C} = 1{\cdot}14$$

Eighth System—Cyanogen (other mixtures).

	V	Q	P
$2 C^2 O^2 + 5 N^2 + O^4$	32	136	7·05
$C^4 N^2 + O^8 + 4 N^2$	28	262·5	12·33
$C^4 N^2 + 4 N^2 O^2$	20	346·3	22·7

We have for the ratios between the numbers relative to the carbonmonoxide $C_2 O_2$ and to the cyanogen—mixed with nitrogen protoxide.

$$\frac{P''}{P} = 3{\cdot}21$$
$$\frac{V}{V''} = 1{\cdot}60$$
$$\frac{Q''}{Q} = 2{\cdot}55$$
$$\frac{C''}{C} = 1{\cdot}27$$

We have also for the ratios between the numbers relative to the carbonmonoxide $C_2 O_2$ and to the cyonogen mixed with oxygen, between which the escape of heat is smaller.

$$\frac{P'}{P} = 1{\cdot}75$$
$$\frac{V}{V'} = 1{\cdot}14$$
$$\frac{Q'}{Q} = 1{\cdot}93$$
$$\frac{C'}{C} = 1{\cdot}26$$

Ninth System—Cyanogen:—Further other Mixtures

	V	Q	P
$2 C^2 O^2 + 3 N^2 + O^4$	24	136·0	8·3
$C^4 N^2 + O^8 + 2 N^2$	20	262·5	14·7

We have thus:—

$$\frac{P'}{P} = 1{\cdot}77$$
$$\frac{V}{V'} = 1{\cdot}2$$
$$\frac{Q'}{Q} = 1{\cdot}93$$
$$\frac{C'}{C} = 1{\cdot}31$$

Tenth System—Acetyline.

	V	Q	P
$2 C^2 O^2 + H^2 + O^6$	18	194·6	10·0
$C^4 H^2 + O^{10}$	14	307·9	15·3

We have thus—

$$\frac{P'}{P} = 1{\cdot}53$$
$$\frac{V}{V'} = 1{\cdot}29$$
$$\frac{Q'}{Q} = 1{\cdot}60$$
$$\frac{C'}{C} = 1{\cdot}35$$

Eleventh System—Ethyline.

	V	Q	P
$2 C^2 O^2 + 2 H^2 + O^8$	24	253·4	9·9
$C^4 H^4 + O^{12}$	16	321·4	16·1

We have thus—

$$\frac{P'}{P} = 1{\cdot}63$$
$$\frac{V}{V'} = 1{\cdot}50$$
$$\frac{Q'}{Q} = 1{\cdot}27$$
$$\frac{C'}{C} = 1{\cdot}17$$

Eleventh System—Methyl.

	V	Q	P
$2 C^2 O^2 + 3 H^2 + O^{10}$	30	312·1	9·9
$C^4 H^6 + O^{14}$	18	359·6	16·2

We have thus—

$$\frac{P'}{P} = 1{\cdot}63$$
$$\frac{V}{V'} = 1{\cdot}67$$
$$\frac{Q'}{Q} = 1{\cdot}15$$
$$\frac{C'}{C} = 1{\cdot}18$$

The sense of the phenomena always remains the same, even notwithstanding the irregularity of the combustions.

CONCLUSIONS.

In general the observed results do not differ very much from those which were calculated according to the ordinary laws of gases, but they have the advantage of being independent of these laws themselves. The result is that, as far as the highest known temperatures—that is to say, towards 3000 to 4000 deg. by the air thermometer—(1) An equal quantity of heat being given to a gaseous system, the pressure of this system varies in proportion to the density of such system. (2) The specific heat of gases is sensibly independent of the density both for very high temperatures and at or about 0 deg. All this is true for the densities near to that which the gases possess when cold and at the normal pressure. (3) The pressure increases with the quantity of heat given to an equal or similar system. (4) The apparent specific heat increases collaterally with this quantity of heat.

These conclusions are independent of all hypothesis upon the laws of gases, and upon their physical and chemical constitution; they are the immediate translation or deduction from actual experiments.

WELL FINDING.

IN the *Times* of February 9th, 1885, appeared the following paragraph:—"The *Allgemeine Zeitung* gives some interesting particulars of remarkable success in indicating the presence of water-springs on the part of a man named Beraz, who seems to be a recognised authority in such matters. The scene of his performance was in the Bavarian highlands, at a height of more than 1300ft. above the level of the sea. The commune of Rothenberg, near Hirschhorn, suffered greatly from want of water, and invited Beraz last autumn to endeavour to find some source of supply for them. He inspected the locality some afternoon in presence of the public authorities and a reporter of the *Allgemeine Zeitung*, and announced that water was to be found in certain spots at depths which he stated. The first spot was in the lower village, and he gave the likely depth at between 62ft. and 72ft., adding that the volume of water which the spring would give would be about the diameter of an inch and a quarter. After incessant labour for four weeks, consisting mainly of rock-blasting, the workmen came on a copious spring of water at a depth of about 67ft. What he declared about a water-source for the upper village was very singular. He pointed to a spot where, he said, three water-courses were perpendicularly under one another, and running in parallel courses. The first would be found at a depth of between 22½ft. and 26ft., of about the size of a wheaten straw, and running in the direction from S.E. to N.W. The second lay about 42ft. deep, was about the size of a thick quill, and ran in the same direction. The third, he said, lay at the depth of about 56ft., running in the same direction, and as large as a man's little finger. The actual results were as follows:—The first water-course was struck at a depth of 27½ft., running in the direction indicated, and having a diameter of ⅛in. The workmen came on the second at a depth of 42⅔ft., it had a diameter of $\frac{5}{16}$in. The third was found at 62½ft. below the surface, and having a diameter of ⅜in.—all three running in the direction Beraz had indicated. Unfortunately no hint is given of his mode of procedure."

We have just received from Herr Beraz the following translation from the *Allgemeine Zeitung*, which we give *verbatim et literatim*:—"In spite of the most expensive machinery of pumps we did hitherto not succeed in securing an abundant water supply for our highly situated Nunnery, Altomünster, near Roehrmoos, Bavaria, which has now—for the last thousand years—almost uninterruptedly been inhabited by conventuals, consequently we had to struggle with a most painful scarcity of water, even during seasons of moderate dryness. Finally, we applied to the well-known spring-finder, Mr. Beraz, at Munich—and the result obtained by his intercession is so brilliant that we deem it our pleasant duty to publish it for the benefit of communities and establishments in want of water. On August 12th, 1885, in the afternoon, Mr. Beraz indicated to us in each of our three highly situated convent gardens—a spot covering a subterranean spring; two hours later he reported in writing on his observations. Spot No. 1 covers a well 80cm. wide, whose strength would be sure to fill a pipe of 1½in. in diameter; spot No. 2, a well as large as a thumb; and No. 3, one as large as a finger, all of which would surely be found at a depth of between 28 and 30 metres, and flowing in the direction from E.S.E. to W.N.W. No external symptom had ever led us to suppose that water was to be found on these spots. Our calamity compelled us immediately to begin at the spring No. 1, indicated as the strongest; rock blasting rendered our work very difficult for several weeks, at last we found at a depth of 29½ metres the well indicated pouring forth crystalline water into the shaft; careful trials by means of the existing pumps have proved the volumen to be 1½in.

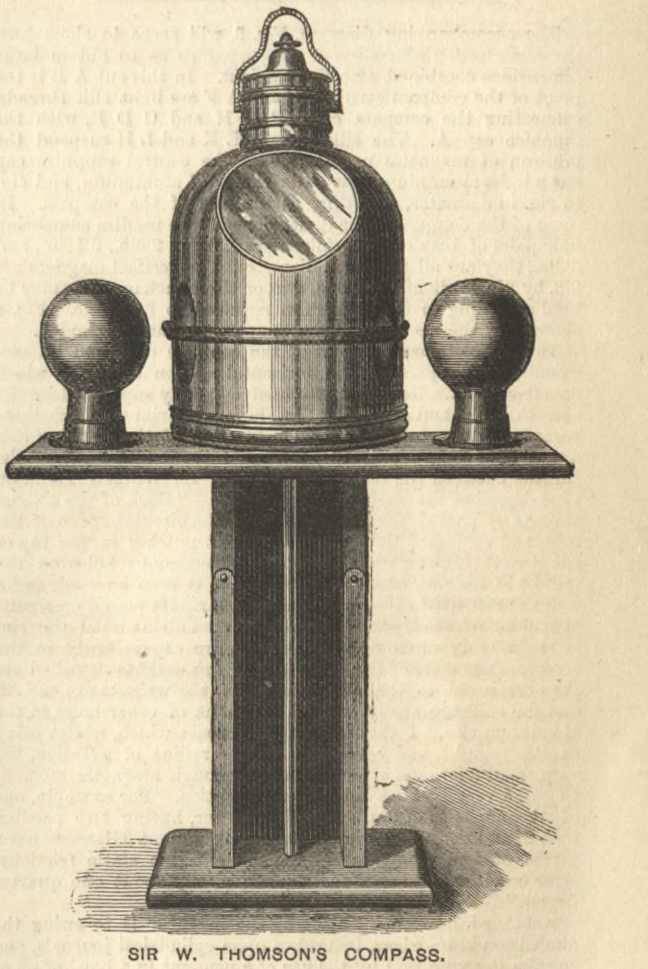
"We now really enjoy a good supply of pure water for household, agricultural, and piscatory purposes, to such a degree that it gives us much pleasure to propagate the name of Mr. Beraz in order to make it known to the parties still suffering from the want of drinkable water.

"Convent Altomünster, December 9th, 1885.

"M. Maximiliana Hirschauer, Prioress, Ord. St. Birg."

SIR WILLIAM THOMSON'S MARINERS' COMPASS.

THE new large passenger steamships of the South-Eastern Railway Company, now plying regularly between Folkestone and Boulogne, are each furnished with one of Sir William Thomson's mariners' compasses, of which the chief features are the lightness of the needles, the keeping of the centre of gravity well below the centre of suspension, and various appliances for correcting sources of error. A perspective view of the compass is given in Fig. 1; sometimes it is furnished with a rectangular box support, and sometimes it rests upon a box of another form, as represented in the cut. Various bar magnets for the permanent adjustment of the compass, lie in horizontal holes bored for their reception in the sides of the box. In this compass the quadrantal error is corrected by means of a pair of solid or hollow unmagnetic iron globes, fixed on each side of the binnacle. The semicircular error is corrected by means of bar magnets placed symmetrically within the binnacle as already stated, and by a Flinder's bar outside the binnacle on the fore or aft side. The heeling error is corrected by three, two, or one bar magnets in a brass can hung by a chain, by which it can be secured at any level and in any position, in a quill tube fixed in the centre of the binnacle, under the compass bowl.



SIR W. THOMSON'S COMPASS.

Sir William Thomson states that the objects of his invention are: (1) By means of smaller needles than in compasses hitherto in practical use, to obtain as long a period of free oscillation as is suitable for working well at sea. (2) Smallness of frictional error. (3) Improved gimbals for supporting the compass bowl, to give sufficient steadiness, and to leave it greater freedom to take up as nearly as possible the true level. (4) Practical methods for applying correctors for the quadrantal semicircular and heeling errors. (5) An improved appliance to the compass for taking magnetic azimuths of sun, or stars, or terrestrial objects, without being impeded by the quadrantal correctors. (6) Improvements in the method of correcting the compass by observation of the sun, moon, or stars on a detached azimuth circle.

Fig. 2 is a cross section of the rectangular box form of the compass stand, of which A B is the door, covering two rows of magnets fore and aft, represented by the unshaded lengths near C D and E F. One row of thwart-ship magnets is placed in the woodwork G H. In the centre K, the can previously mentioned slides within a quill tube, and can hold three magnets if required. M N is a strip of brass covering the ends of the thwart-ship magnets, and by means of which they can be locked in.

SIR WILLIAM THOMSON'S MARINER'S COMPASS.

FIG. 6

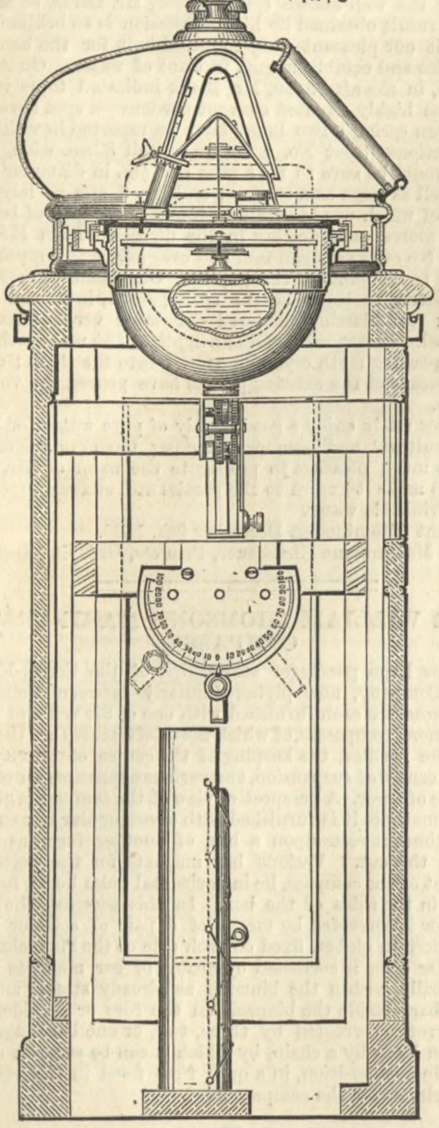
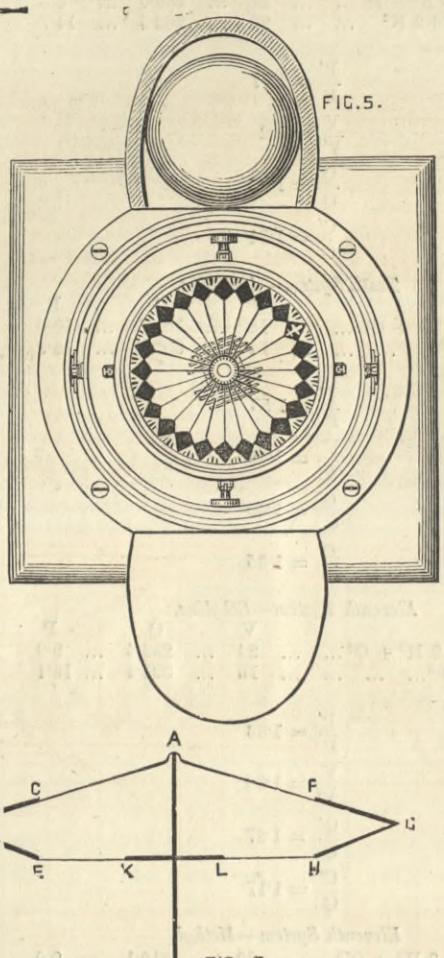


FIG. 5.



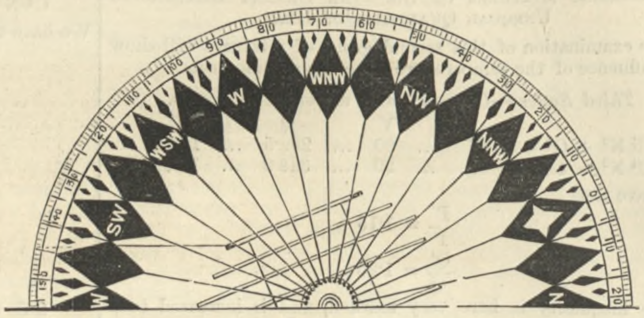


FIG. 4.

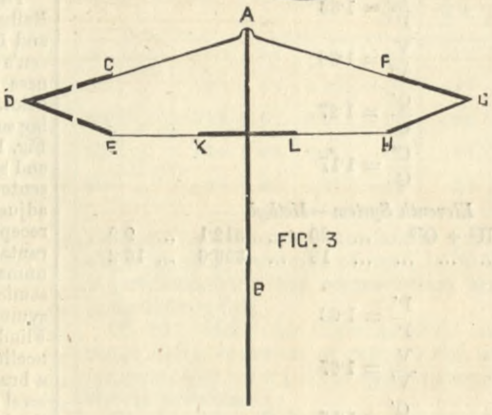


FIG. 3

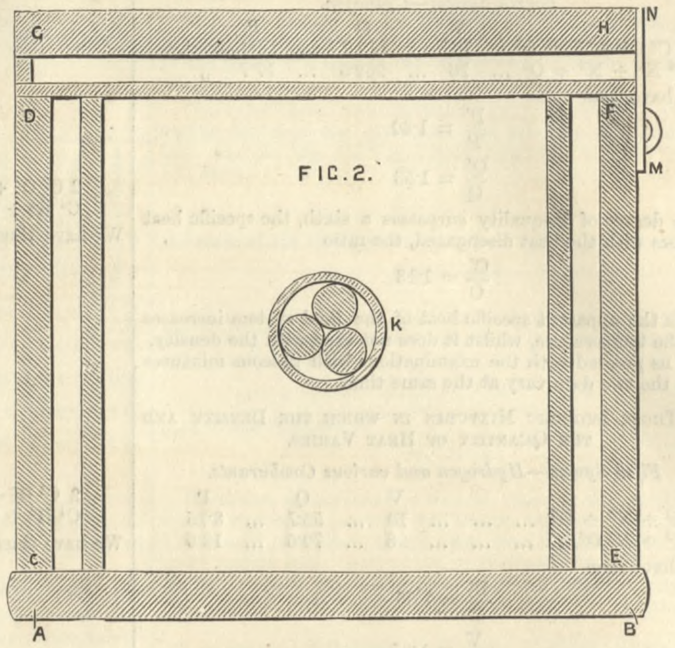


FIG. 2.

The accompanying diagram, Fig. 3, will serve to show how the combination of needles is supported, so as to obtain large dimensions combined with light weight. In this cut A B is the pivot of the compass card; A C and A F are light silk threads, connecting the compass card, F G H and C D E, with the sapphire cap A. The silk threads E K and L H suspend the gridiron of magnetic needles K L. The central sapphire cap has a light aluminium boss; the rim is of aluminium, and 4in. to 9in. in diameter, according to the size of the compass. In some of the compasses the dimensions of the needles composing four pairs of bars of the gridiron are 2·05in., 2·9in., 3·15in., and 3·3in., they are all ·042in. in diameter. The vertical magnets are 9in. by ⅜in. in diameter; one, two, or three such magnets may be used according to the correction required to be made. Fig. 4 shows how the needles and the compass card are suspended.

The complete arrangement of the compass card and its surroundings is represented in horizontal section by Fig. 5, which explains itself. The compass card is partly supported by the silk threads, and partly by the aluminium rim to which these threads are attached. In the construction of the compass it is a matter of some nicety to give equal tension to each of the threads between the boss and the rim. Sir William Thomson thus describes his method in his patent:—"Each of the sixteen threads is passed through a hole in the circumference of the boss, and stretched thence into two light notches in the top of the rim, then down and through two contiguous holes on the middle of the rim, one end of the thread is then knotted, and a weight attached to the other end. The rim is placed on a suitable circular stand, and the boss is worked about until the rim is made truly circular, and the sapphire cap is truly in the centre. The ends of the threads with the weights attached are then cemented to the aluminium rim, the weights are cut off, and the ends are firmly secured by means of other holes in the aluminium rim. I thus obtain a compass which, whilst being extremely light, and yet having a large radius of gyration, has very small frictional error with small enough magnetic moment to give a very long period of free vibration. For example, one of my compasses of 9in. over all diameter, having two needles, each 2½in. long, weighs in all 104 grains and at Glasgow has a period of free vibration 62 secs., and extreme static frictional error on either side of the true position only about one quarter degree."

Another improvement made by the inventor is to swing the gimbals on knife-edges, instead of upon cylindrical journals, and to calm the vibration by the use of a pendant in a bowl of oil or liquid, or by means of a very viscous liquid without pendant, to give greater freedom to the compass to assume a horizontal position. A small spirit level in the glazed case in which the compass is supported indicates whether the case and bowl are properly balanced. By the use of knife-edges he loses the energy-destroying power of the rubbing surfaces, so he uses instead a large bowl attached to the bottom of the glazed case; the bottom of the case forms the roof of the bowl, and the bowl is nearly filled with liquid. Thus, when there is any motion, energy is consumed by the viscous action of the fluid. The correctors for the quadrantal and semicircular errors are founded on the principles first given by Sir G. Airy, the late Astronomer Royal, and are described in detail in the patent. The inventor further places a convex half lens over the graduated circumference of the compass card, and the lens has a plane mirror attached for observing the image of an object whose azimuth is required, and by the means provided the bearing of the object is readily seen. Another improvement consists of appliances for finding the true North by means of direct observation of the sun, moon, or any other bright star or planet; allowance has to be made for errors due to refraction.

Fig. 6 is a sectional elevation of the whole instrument. Professor Thomson says that one of his compasses, of 10in. over all diameter, having eight needles from 3in. to 1¾in. long, weighs in all 178 grains, and at Glasgow has a frictional error on either side of the true position of less than one quarter of a degree. He holds that the steadiness of compasses at sea is not to be obtained by heaviness of the needles, which produces extra friction upon and dulls the bearing point, and renders the compass less steady and decided, but that the means herein stated are theoretically and practically necessary to increase the vibrational period.

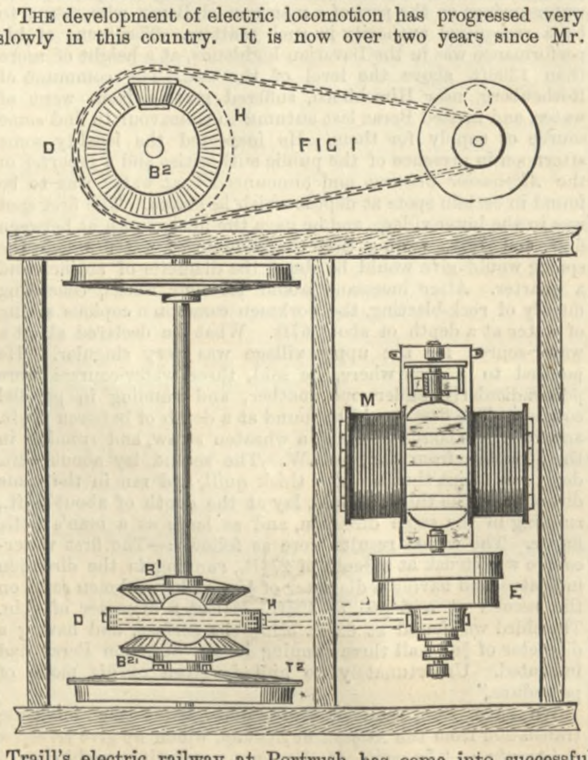
In the course of an address delivered by Sir William Thomson to the Liverpool Mercantile Marine Association, he said:—"The period of the new 10in. compass is in this part of the world about 40 seconds, which is more than double the period of the A card of the Admiralty standard compass, and is considerably longer than that of the ordinary 10in. compass, so much in use in merchant steamers. The new compass ought, therefore, according to theory, to be considerably steadier in a heavy sea than either the Admiralty compass or the ordinary 10in. compass, and actual experience at sea has thoroughly fulfilled this promise. It has also proved very satisfactory in respect to frictional error; so much so that variations of a steamer's course of half-a-degree are shown instantly and surely, even if the engine be stopped, and the water perfectly smooth."

The compass is manufactured by Mr. James White, of 241, Sauchiehall-street, Glasgow. Recently Mr. A. Haddon, Demonstrator of Physics at the Royal Naval College, Greenwich Hospital, partly dissected one for our inspection at that establishment, where it is kept for the purpose of educating young naval officers in the principles of the mariner's compass.

THE BLACKPOOL ELECTRIC TRAMWAYS.

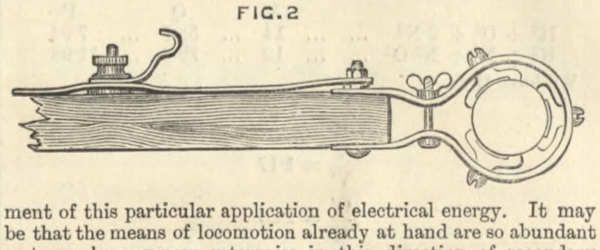
THE development of electric locomotion has progressed very slowly in this country. It is now over two years since Mr.

FIG 1



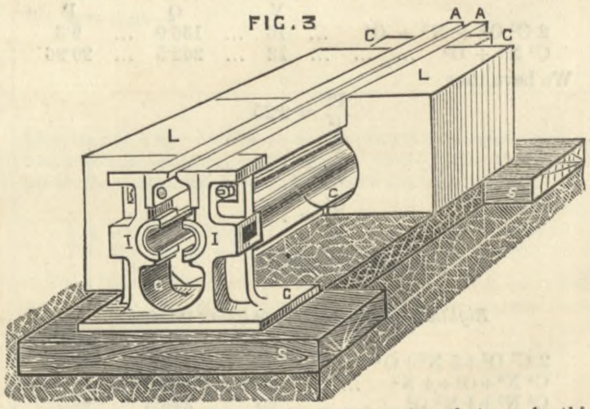
Traill's electric railway at Portrush has come into successful operation, but in spite of this encouraging example no other works of a similar character have been attempted. There is, indeed, a short line of narrow gauge at Brighton, due to the private enterprise of Mr. Volk, but of great public undertakings in this direction nothing was heard until very recently, when the opening of the Blackpool electric tramway was announced. It is difficult to assign a reason for this slowness in the develop-

FIG. 2



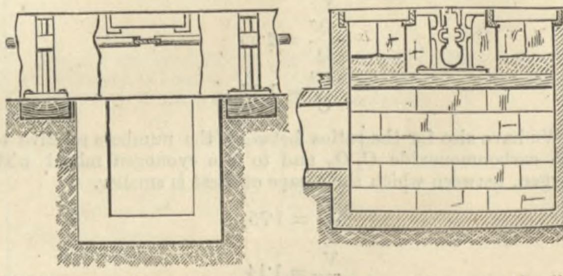
ment of this particular application of electrical energy. It may be that the means of locomotion already at hand are so abundant as to render any new enterprise in this direction of secondary importance, or it may be that the check experienced by the electric lighting industry has reacted also upon other applications of electricity, and thrown financial difficulties into the way of

FIG. 3



all things connected with it; the fact remains that we in this country are in this respect not only behind our cousins on the other side of the Atlantic, but also behind the Continent. At the time when the Portrush Railway approached completion, there were in Germany and Austria alone the following electric railways already in use:—(1) Lichterfelde near Berlin, 1½ miles; (2)

FIG. 4

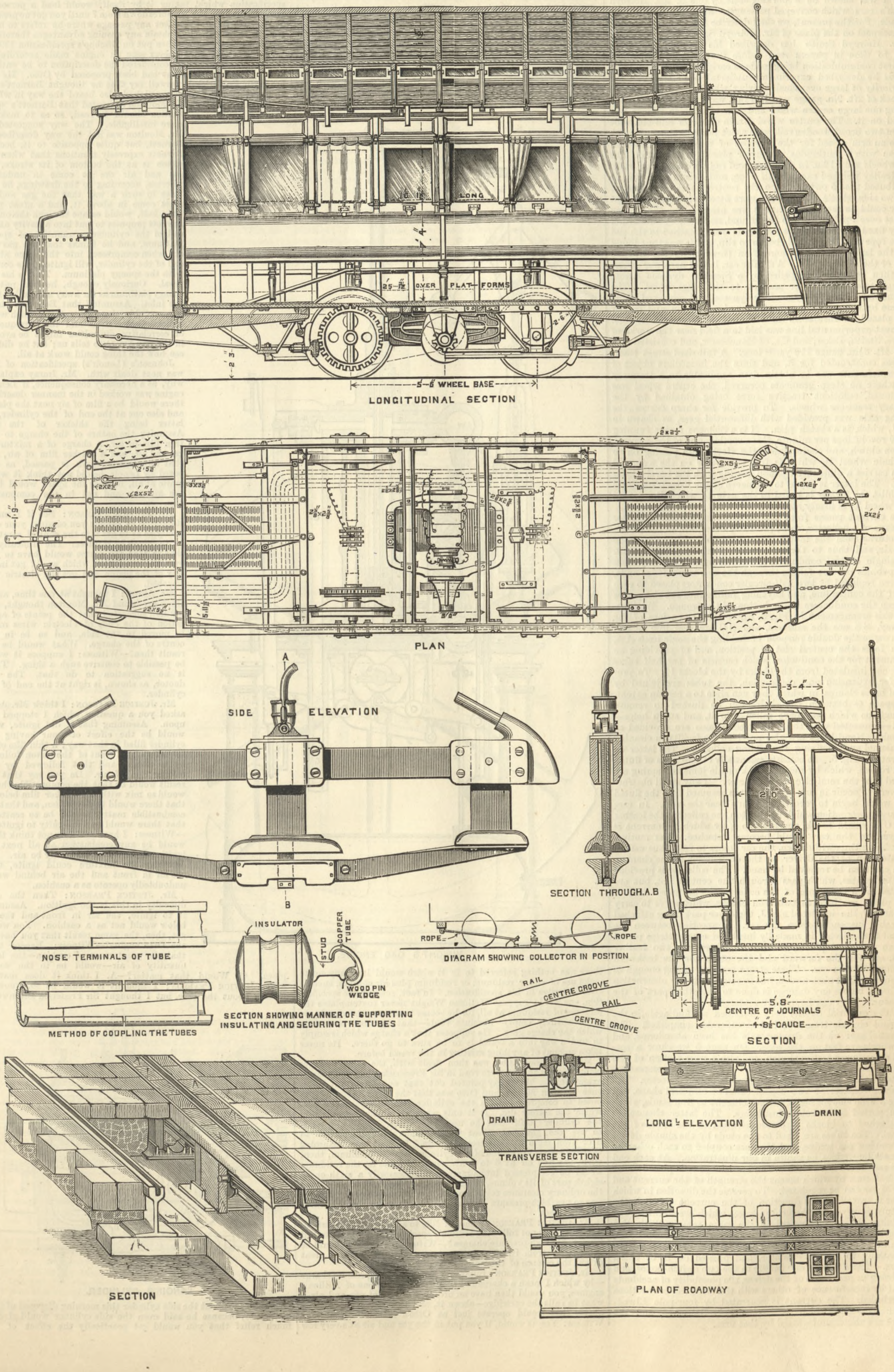


Mödling near Vienna, 2 miles; (3) Frankfurt-Offenbach, 4⅛ miles; (4) Zaukerode Mine, ⅜ mile; (5) Hohenzollern Mine, ½ mile; (6) Neu Stassfurt Mine, ⅜ mile. Two systems of electric tramways were shown at the late Inventions Exhibition, which may be considered as fairly typical of the general problem. In one system each tram-car carries its own store of power with it,

THE BLACKPOOL ELECTRIC TRAMWAY.

MR. HOLROYD SMITH, HALIFAX, ENGINEER.

(*For description see page 4.*)



and is thus independent of any electrical connection along the road, in the other system the electrical energy is conveyed to the car by means of a conductor laid along the line. The former system was exemplified by a small working model of a tram-car constructed on Mr. Reckenzaun's principle, and provided with two of his motors and with storage cells, whilst the latter system was shown on a working scale by one of Mr. Holroyd Smith's cars which conveyed passengers along the South Promenade. For the present, we shall describe the tramway erected at Blackpool on the plans of Mr. Holroyd Smith.

Mr. Holroyd Smith has described his experiments from time to time in papers read before the British Association, the first communication being made as early as September, 1883. In this he described experiments undertaken to ascertain the superiority of large over small driving wheels. A short length of track of 2ft. 9in. gauge was laid in a warehouse, and a trolley having one large centre wheel and two small side wheels was placed on it. The centre wheel 3ft. in diameter and 6in. wide ran on two broad wooden rails with a slot between them, through which an arm passed for the purpose of making electrical connection with a continuous conductor placed underneath. The side wheels were 12in. in diameter, and ran on angle iron rails. The trolley weighed exactly half a ton, and this weight was so distributed that 5 cwt. came on the centre wheel and 5 cwt. on the two side wheels. Both axles were fitted with gear so that either could be revolved. A rope was attached to the trolley and let over a pulley fixed to the ground, and thence over another pulley fixed to a beam above. Weights were attached to the end of the rope until the wheels began to slip, and it was thus found that the large wheel had more than three times the tractive force of the small wheels. A similar car, but of narrower gauge, was then built, and propelled by a Siemens dynamo acting through two sets of spur gear on to the large wheel. The current was generated by another dynamo, and conveyed along the line by two conductors consisting of angle iron and copper wire placed on insulators in a central underground trough. The next experimental line was laid in a field near the works of Messrs. Smith, Baker, and Co., of Manchester, and consisted of a track 4ft. 8½in. gauge 110 yards long. A full-sized street tram-car was constructed for it, and since the immediate object of the experiments was to obtain data applicable to a tramway line where no steep gradients occurred, the centre wheel was abandoned, sufficient tractive force being obtained by the ordinary tram-car wheels. To provide for sharp curves the driving axle was provided with differential gear, as shown in Fig. 1, which is a sketch plan. M is a Siemens motor running at 650 revolutions per minute, E is a combination of box-gearing, friction clutch, and chain pinion, the steel chain passing on to the chain wheel H, which is free to revolve on the axle, and which carries a differential pinion gearing with the bevel wheels B_1 B_2. The latter is keyed to the sleeve of the loose tram wheel T_2, whilst the former is keyed to the axle to which the second tram wheel T_1 is firmly attached.

The current passes from the underground central conductor by means of a collector, to be presently described, to the motor, and returns from the motor to an adjustable clip—Fig. 2—to the axle, and thus to the rails which form the return circuit. The single central conductor, which was open to the objection that pebbles or dirt falling through the slot would lodge on it, has been replaced by two half-circular conductors placed to each side of the centre line, and anything falling into the slot passes between the conductors to the bottom of the trough. We illustrate this arrangement in Fig. 3, where L is the surface of the roadway, S S are the sleepers, and C C are cast iron chairs, which serve the double purpose of holding the angle irons A A, which form the central slot in position, and of providing an attachment for the conductor, which consists of two half tubes of copper insulated from the chairs by the blocks I I. To provide for expansion and contraction, the tubes are joined by special brass clamps, in which they can slide to a certain extent. The space G between the chairs can be flushed to remove obstructions which may have fallen into it, and sump holes—Fig. 4—connected with the main street drains are provided at intervals. Hand holes are also provided for facility in cleaning the channel and in fixing the sliding collector. The latter we illustrate in Fig. 5. It consists essentially of two pairs of fluted metal rollers, which by means of a knuckle joint and spring are pressed into the semi-circular conductor. If any small obstruction were to occur in one of them, it is assumed that the fluted roller would begin to revolve, and thus clear the tube. In case of a large obstruction which would stop the collector, the leather belts C C would break, and the clip J, by which the current is conveyed to the car, would become detached. The motive-power being thus withdrawn, the car comes to rest, thus calling the attention of the driver to the obstruction in the channel, which can then be removed by hand. The collector is provided with steel plates, which pass through the central slot, but are insulated from the frame of the collector. The upper ends of these plates are held in two iron cheeks, which serve to carry one part of the insulated clip J, the other part being attached to a cable suspended from the car. Connection between the clip and the collector is made by insulated copper strips placed between the steel plates, as shown. There are two leather straps, one for the forward and the other for the backward movement of the car. These straps are just strong enough to overcome a slight obstruction, but in case of a heavy obstruction they break before any damage is done to any other part of the apparatus. They can be quickly replaced.

All the essential details here described we find again in the Blackpool electric tramway, but considerably simplified. The differential gear on the driving axle has been abandoned, and both wheels are fast on the axle. On page 5 we show a sectional elevation, a sectional plan, and also a cross section of the car. We also show a part section of the roadway in perspective, and various details relating to the conductor and collector. The conductor consists of two copper tubes of elliptical shape, and having a wide slot for facility of attachment to iron studs, which are supported in porcelain insulators. The latter themselves are attached to blocks of creosoted wood in the sides of the channel. The tubes are fixed to the studs by the simple device of a wooden pin wedge, and they are coupled to each other by two metallic wedges, as shown in our illustration. At each end of the case there is a switch box and resistance coils placed under the platforms, by which means the strength of the current and speed of car can be regulated. To reverse the direction in which the car is travelling, the direction of the current through the armature is reversed, the field magnets which are shunt wound remaining always magnetised in the same sense. With this arrangement there is no need to alter the position of the brushes, which in this case consist of two parallel sets of plates placed tangentially to the commutator, and pressed on it by spiral springs. There is only one handle to the two switch-boxes, and that being in possession of the driver, the possibility of accidents caused by interference of others with the electrical connections is precluded. The current is generated by four-pole Elwell-Parker dynamos, which we have already described, and the motors are also manufactured by that firm.

LEGAL INTELLIGENCE.

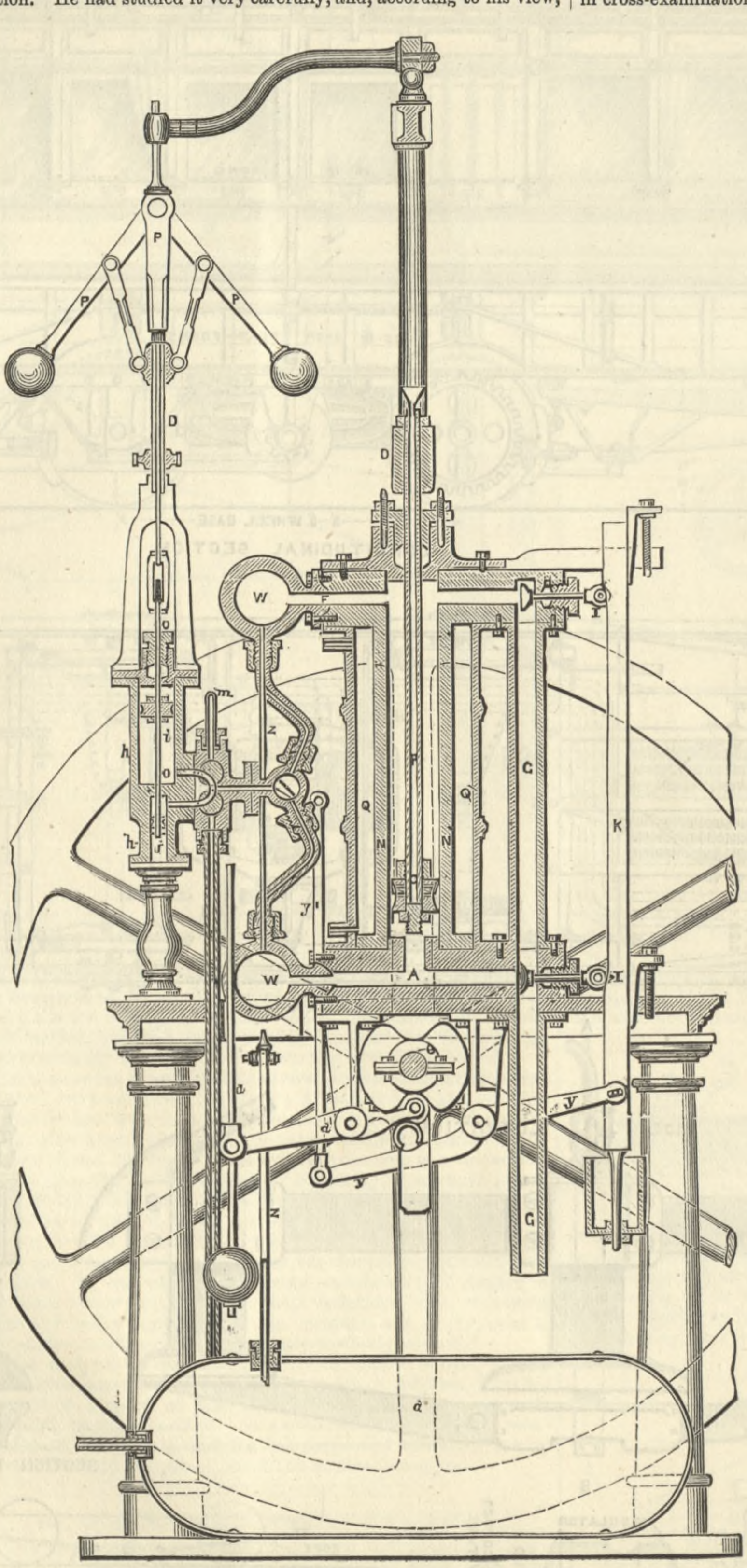
HIGH COURT OF JUSTICE, CHANCERY DIVISION.

Before Mr. JUSTICE PEARSON.

OTTO *v.* STEEL.

IN our last impression we suspended the publication of our report of this trial to give the judgment. We now resume, at the point where we left off, the examination of Mr. Imray.

Mr. Imray was next questioned as to the alleged anticipations and publications. He stated that in all engines of every kind there must of necessity be some amount of clearance space, but that he understood it might be a very good invention if a man points out how a thing that has been done before may be made a useful thing, and an advantageous thing. He fully agreed with Sir Frederick Bramwell in his remarks on Wellman Wright's specification. He had studied it very carefully, and, according to his view,



WRIGHT'S GAS ENGINE.

there was nothing referred to in it which would lead anyone to make use of either residuum or residuum plus air charges, such as Otto describes in his specification. In fact, reading the specification, one would suppose Wellman Wright never contemplates the presence of residuum at all, for he seems to assume the vessels are to be entirely empty—absolute voids—that is, the vessels into which the charge goes. He supposes that a charge which is simply to find a way into a vessel is to be sure to go there. He never takes account of anything existing in the vessel before.

Million's specification was then dealt with, the same passages being referred to that were read in Sir Frederick Bramwell's cross-examination. Mr. Imray pointed out that one important difference between Million and Otto was that the latter, when he proposed to compress outside the cylinder, left no clearance space, which the former did. It is only when Otto compresses within the cylinder itself that he uses the space. Million intends to use the gas and air at very considerable pressure—6 to 8 or even more atmospheres, he says. In that case, assuming that the spaces at the end of the cylinder contain residuum, then, when gas and air at 6 to 8 atmospheres come in, the residuum would be compressed into a mere film, necessarily a sixth or an eighth part of its volume, which would not amount to more than the ordinary clearance residuum. The principal object of Million was to use high-pressure charges in order to make the apparatus more compact.

Mr. JUSTICE PEARSON: I should like to ask you this question. Should you be not following Million's specification if you abstained from using high-pressure charges?—Witness: I think I should be going away from it. The high-pressure charges are to a great extent the essence of this specification.

Mr. JUSTICE PEARSON: Supposing you put a low-pressure charge—by which I mean a charge not compressed—into one of Million's engines, you would then have an ordinary charge of gas and air—what he calls the cartridge—above it, and the piston above that. Surely that would operate just as Otto's machine operates?—Witness: Yes, it would, if you put in the gas and air at a very low pressure; but I read in the specification, at page 3, line 25, that a means by which he proposes to remove defects is:—"Secondly, by first compressing the gases, and introducing them under pressure, so as to require very small engines in proportion to the power produced." All through the specification, as far as he knew, Million referred to no other pressures than those high pressures varying from 6 to 7 and upwards. There was nothing throughout that specification which, taking it by itself, would lead a person to gradually reduce the pressures down from 7 until you got no pressure at all. He did not recollect any passage where he refers to being able to reduce shock or obtain any ensuing advantages therefrom.

A few questions were then put on Bischop's specification 1594, of 1872. The witness had never seen an engine made according to this specification, and he considered the description to be entirely different to anything that had been proposed by Otto. He had heard Sir Frederick Bramwell say that he thought Barnett's was an impracticable machine, and had also heard the way in which, in cross-examination, Mr. Moulton suggested that Barnett's specification should be read, so as to make it more intelligible. The way suggested by Mr. Moulton was not the way described by Barnett, but quite opposite to it, because Barnett expressly mentions that when the piston is at the bottom of its stroke, the gas and air are to come in under it, whereas, according to the drawings, he provides in such a way that the gas and air must come in above it, and a great part, fully half, would escape through the outlet. Barnett proposes to put into a cavity at the end of the cylinder a quantity of spongy platinum, and he thinks that the gas and air, when compressed into the space at the end of the cylinder, will ignite by its contact with the spongy platinum. That is his proposal. Curiously enough, he had put his spongy platinum as far away as possible from the inlet. Assuming that Barnett's engine was workable, there was nothing which would indicate that a shock and its consequences or correlative difficulties might be avoided in the way Dr. Otto tells us; but he did not see how the thing could work at all.

Johnson's (Lenoir's) specification of 1860 was next dealt with. Mr. Imray explained why, as a necessary consequence, if Lenoir's engine was worked in the manner described, there would be a film of air next the piston, and also one at the end of the cylinder, the latter being the thicker of the two. Assuming the nature of the charge to be a thin film of air, a charge of a mixture of gas and air, and a thicker film of air, and that an electric spark is passed, as proposed by Lenoir, he did not think it would ignite at all, because the spark would be in the air film and not in the combustible film.

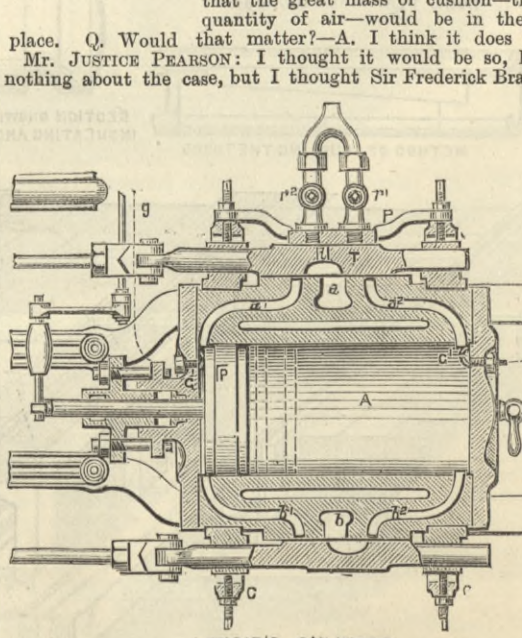
Mr. JUSTICE PEARSON: See if I understand. Why cannot you conduct your electricity so as to get into the central stratum, so to speak?—Witness: The difficulty of that is that the piston would have to pass over the conductor, which would get in the way of the piston and get the electric wire smashed.

Mr. ASTON: I thought at one time, and I think my friend Mr. Moulton thought, that my lord suggested that the points of application of the ends of electric wires might be moved to the side, and so be in the centre of the charge. What would be the result then?—Witness: I suppose it would be possible to contrive such a thing. There is no suggestion to do that. The conductor, as shown, is right at the end of the cylinder.

Mr. JUSTICE PEARSON: I think Mr. Aston asked you a question which I stopped you upon. Assuming that it did ignite, what would be the effect of your having the cylinder filled in that way; a thin film of air immediately in front of the piston followed by a charge, and that followed by the thicker film of air. Do you say that the result would be that the combustible charge would so mix with the thicker film below it that there would be no ignition, and that the combustible matter would be so scattered that there would be a difficulty to ignite it?—Witness: I have said I do not think there would be any combustion at all next the igniting light. It would only be air. But assuming the mixture could ignite, then the air in front and the air behind would undoubtedly operate as a cushion.

Mr. JUSTICE PEARSON: Then the only difficulty in this is the ignition. Assuming it to ignite, the air in front and the air below would act as a cushion. You would get, then, the same result that you have in the Otto engine?—Witness: Except this, that the great mass of cushion—the large quantity of air—would be in the wrong place. Q. Would that matter?—A. I think it does matter.

Mr. JUSTICE PEARSON: I thought it would be so, knowing nothing about the case, but I thought Sir Frederick Bramwell's



LENOIR'S CYLINDER.

answer to me about the side cylinder this morning disposed of that altogether, because he said even the side cylinder would give so much relief that you would get practically the effect of the cushion?—Witness: I think so. I quite agree that that is so.

Mr. ASTON: Would the quantity which is there be sufficient to obviate shock in the way that Otto describes?—As far as it is gathered from the drawing I should say that quantity was extremely small. There is nothing else to guide one as to the quantity, but apparently it is intended that it should be an extremely small film.

Mr. JUSTICE PEARSON: Not below?—An extremely small film coming in at first, and that naturally involves a much larger film coming in behind.

Mr. ASTON: No, no!

Mr. JUSTICE PEARSON: If you had two films, the thin film in front and the large film behind, would not that in effect have the same operation as having no film behind and a large film in front?—Witness: To a certain extent it would.

The witness then pointed out that the patentee, curiously enough, did not seem to understand that air is as much a part of the combustible mixture—in fact more—as other gases. He seemed to imagine that the gas alone burns, and that the effect of that is to heat the air. He says so in effect. The description was the description of a person who really did not understand the action of gas and its ignition.

Mr. JUSTICE PEARSON: But this is communicated by Lenoir.

Mr. ASTON: Yes.

Mr. JUSTICE PEARSON: Lenoir knew something about it.

Mr. ASTON: This is Lenoir's first—1860. When he comes to his 1861 he has got hold of it. In 1861 he introduced what Sir Fred. Bramwell has called his pencil arrangement in order to effect a complete mixing of the gases, so that the charge might be made absolutely homogeneous. That is to say, each stream of gas was surrounded by an annular stream of air. The engines of Lenoir's that Mr. Imray had seen were neither made according to 1860 nor the 1861 patent. They were the 1860 with slide altered in order to change the condition of things, and allow gas to enter first into the cylinder.

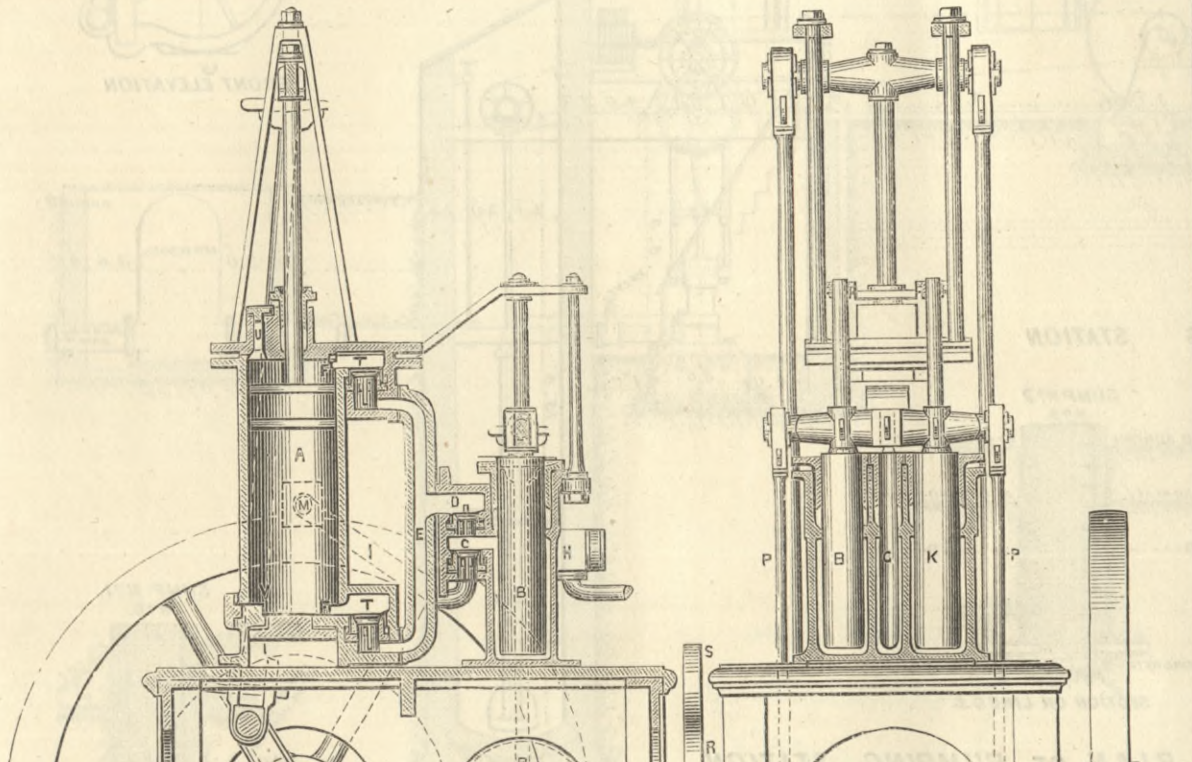


FIG.1. FIG.2.

BARNETT'S GAS ENGINE.

Mr. JUSTICE PEARSON: That is to say, to exclude the thin film of air that was brought in first?—Witness: And also the thick film brought in last. The witness had found that when any work was put upon a Lenoir engine there was shock. Whenever you chose to work the engine without doing any work except moving itself, you could so far reduce the supply of gas or increase the supply of air as to make it move without sensible noise; but when you put some little strain on the engine so as to make it overcome some resistance, you at once heard a thud at every explosion. He had tested this at South Kensington the other day, and had found the same result with the Hugon engine.

Mr. JUSTICE PEARSON: Then if you stand near an Otto engine when it is fully working and doing some business, is the only noise that you hear the noise of the gearing and the wheels?—Witness: That is really all, my lord. It is quite silent. The clearance in the engines at South Kensington was just the ordinary clearance that an engineer would make for an engine—nothing extraordinary. He did not think that either of those engines worked on the Otto plan at all. The Petworth one was very much the same as the Lenoir one in the South Kensington Museum. It had the same alteration of slide for the purpose of introducing the combustible m xture throughout the induction stroke—exactly the same arrangement of slide, and it worked in very much the same way. In fact, the day that he was there it was rather difficult to get it to work at all. The man that had charge of it for so long tried it all sorts of ways, and he found extreme difficulty in getting it to work. He said this was not due to its being out of order. He said it was in the ordinary state. It had to do some pumping there, and he was obliged to set men to work to pump because the engine would not do it. He had made inquiries as to the gas used, and found it was a very large quantity. He could not very well estimate the power except in this way—that he got a couple of men to turn round the fly-wheel, and he found that when the gas engine turned the fly-wheel and did the same work, it must have taken, reckoning five men to a horse, 90 to 100 cubic feet of gas per horse-power per hour. That is a rough estimate. A good Otto engine takes 20ft. to 24ft. The conclusion he drew from this was that he did not wonder that these Lenoir engines have been thrown aside as useless. In addition to the experiments he had mentioned, he had a Sterne engine, which was arranged in such a way that he could take off a sample of charge at three different parts of the cylinder—one near the ignition port, one about midway in what would be the air space, and one close up to the piston. The samples were taken off just after the compression, that is, on the completion of the compression at the time when the ignition should take place. The charge was taken in in this way—first of all, when the piston came to the end of its instroke there was a substantial body of residuum followed up by a quantity of air, and that followed up by a quantity of mixture of air and gas, the latter two being forced in by a pump. Thus there was, as it were, three what you may call strata, three layers. There would be next the piston, as we assume—because we are assuming this—residual products, then in the middle there would be air, and then at the ignition port there would be combustible mixture. That is what would appear from the working of the engine. In order to test this as I said, we took a sample of each. Three bladders were charged. Then we took those bladders and put a quantity from each into a eudiometer tube and fired it by an electric spark and tested as well as we could by the contraction of volume the quantity of combustible that was in each. Of course, the more combustible there was, the greater would be the contraction of volume, and so the water would rise in the eudiometer tube after the explosion. He found that that which was taken nearest the ignition hole contained a substantial body of gas, for this reason, that a volume which measured ten units in mixture became reduced by about one and a-half in the tube, so that one and a-half in ten would be about the proportion. Then that which was taken from the middle part contained extremely little combustion, because a volume of ten units got reduced only by about two-tenths, and that which was taken from next the piston was much about the same—rather less if anything. That showed that next the touch-hole there was a rich combustible mixture; in the middle there was one very far from rich, and at the piston also one very far from rich. Then to show that both the latter contained a substantial quantity of air, he afterwards in the same eudiometer tube, after the combustion, let in a quantity of gas, and then he fired that again without further air. That showed there was a slight quantity of air there which had met with no gas to take it up. Having regard to the result of these experiments, he was satisfied that there is reason to believe that the description of Otto as regards stratification was in general correct, and that there was a real difference of quality in the different parts of the cylinder. Even if some laws of gases, or something that they might be favoured with by-and-bye, should upset that theory, it would not in any way affect all that he had said with reference to the utility of Otto's machine as it is made. Whether the theory is right or wrong, it would not at all affect what he had said with regard to the directions that are given to enable the beneficial results stated to be obtained. He would say that following the directions given in Otto's specification, you would produce an engine which is far better than anything that went before it in the direction that he mentions.

This concluded Mr. Imray's examination-in-chief.

At the commencement of the fourth day's sitting some discussion took place as to the publication of some of the alleged anticipations, also as to which of the patents now brought forward were before the Court of Appeal in Otto *v.* Linford.

Mr. John Imray was then cross-examined by Mr. MOULTON. Referring to a passage in one of the judgments in the Linford case, which was read, witness said that the statement there attributed to him was a mistake. He had said that if you had an explosion you would have a line going up straight and a line descending very rapidly. He defined an explosion as a case in which the charge explodes or burns almost instantaneously. It had nothing to do with the pressure. If the pressure rises to a certain height in one engine in one time, and in another engine in half that time, he considered that the latter is more explosive than the first. You must also consider the extent to which the expansion takes place afterwards—the nature of the expansion afterwards. There may be an expansion in an adiabatic line, which shows no accession of heat. There may be an expansion with a pure adiabatic line, afterwards showing that the whole effect of combustion has taken place at once; or there may be an expansion even greater—a higher pressure in a shorter time—and yet there may be a line not descending so rapidly as the adiabatic, showing still more combustion after the first explosion. The witness then explained what an indicator diagram is, and how it is taken.

Considerable discussion then took place as to the meaning of the word explosion, Mr. Moulton's object being to show that the Otto engine was very greatly more explosive than any engine which ever came before it. The time taken for the pressure to rise to a maximum in the Otto engine was about the thirtieth part of a second, and the pressure rose from 30 lb. to 150 lb. per square inch. As far as he had seen from diagrams of the Lenoir, it took about the tenth part of the time of the Otto. He had ascertained this by measuring the slope of the curve of expansion in the Otto and in the Lenoir. The Lenoir rises a little more rapidly than the Otto, but the Otto takes place when the piston is moving very slowly. The Lenoir takes place when the piston is moving very rapidly, and that makes all the difference of time.

Mr. MOULTON then called attention to an article in the *Journal of the Franklin Institute*, in which diagrams were given taken from the Lenoir engine, and calculations showing that the actual time taken for the rise to maximum pressure was one twenty-seventh of a second. In reference to this Mr. Imray pointed out that in this case the engine was only running at a speed of 45 revolutions per minute, while his estimate was based on 160. Asked by Mr. Moulton if this would make any difference, he said it would, and that the composition of the charge would vary with the speed. He had seen an engine going at a slow speed, such as 45 revolutions, with an extremely dilute charge, but if you want to drive it at a high velocity, such as 150 or 160 revolutions, you must give it a rich charge. There would be a substantial difference between the charge when it was working at 160 and when working at 45.

Mr. JUSTICE PEARSON: Suppose you have the fact of the same engine, the same cylinder, and the same piston, I mean the same weight that you have to move, on one occasion you have only a small piece of work to do and you are content, therefore, with a moderate number of revolutions, say 50; on another occasion you want to get 150 or 160 revolutions. How would you adapt the charge in the two cases? Would you adapt the charge in the first case by putting in the same mixture only diluted, or would you put in a similar charge in the first instance with the same rich matter, rich I mean in proportion, and a larger charge? Witness: You cannot change the volume of the charge. The total volume of the charge remains the same in both cases; all you can do is in the one case use a mixture of little gas and much air, and in the other case to use a mixture of much gas and comparatively little air. In reply to Mr. Moulton he said he had never seen a diagram from a Lenoir engine at 160 revolutions. As far as he recollected it was 130, but he had not got the diagram. He had tried an experiment in which there has been a uniform mixture in a chamber without any complications of piston or anything at one end; but he considered that the combustion in that case would be very nearly instantaneous. You might have a mixture in a cylinder which burns almost all at once, almost instantaneously, and it is done with. You might have a mixture in a cylinder, a large part of which burns at once, but it is not done with, it goes on burning afterwards. He found from what he had seen that a homogeneous mixture is of the first character, that it burns and is done with, but if it is not a homogeneous mixture it burns and then goes on burning. All the diagrams for the Lenoir engine that he had seen show that the combustion was complete at the moment of maximum pressure. He ascertained that by the form of the diagram, *i.e.*, from the rapid descent of the curve from the point of maximum. You had to make allowance for conduction of heat and the conversion of heat into mechanical work. The witness was then asked as to the various modifications of the Otto engine. He did not know if any engine had been made according to modification 2, and admitted that as a matter of fact every engine that has been sold had compression within the cylinder. Certain small improvements in details had been made since 1876, *e.g.*, in the igniting arrangement. He had never measured the proportion between the stroke and clearance space in the actual Otto engines, but knew it substantially accorded with what was shown in the patent. He did not know that at least 100 Lenoir engines were sold in this country, but had heard the contrary. He did not know that Lenoir engines had been working up to the present day, with the exception of the engine at Petworth.

Mr. JUSTICE PEARSON: I should like to know whether this is correct, that there was one of the Lenoir engines in the possession of the Society of Civil Engineers?—Witness: Yes; he believed it worked a short time. It was removed a good many years ago.

Mr. MOULTON: It was either a Lenoir or a Hugon at the Civil Engineers'. Dr. Hopkinson thinks it was a Hugon.

Mr. JUSTICE PEARSON: Sir Frederick Bramwell spoke of it as a Lenoir. If I remember right, he said he had never taken it to pieces. He having had, so to speak, the custody of it as a member of that society, he might have known more about it than the others. —With regard to the Petworth engine, Mr. Imray said he did not know it was still doing regular work. The gardener told him he had a great deal of difficulty to get the pumps to go at all with it. When he was there they tried to work the pumps, but they did not succeed. It had been on pumping work for twenty or twenty-five years, but he doubted whether it had really done much practical pumping work. The day he was there it required a great deal of coaxing to make the engine go at all, and when they put on the pumps and tried to work them the engine stood stock still. That was not due to the difficulty of ignition with the electricity, but merely to want of power; it did not seem to be able to do the work, and then they put two men on to the fly-wheel, and, with the assistance of these two men, they worked the pumps.

Mr. JUSTICE PEARSON: I suppose on the day you saw the Petworth engine the gardener expected it to work, did he not?—Witness: He did his best; he said he could make it go, but he said there were great difficulties.

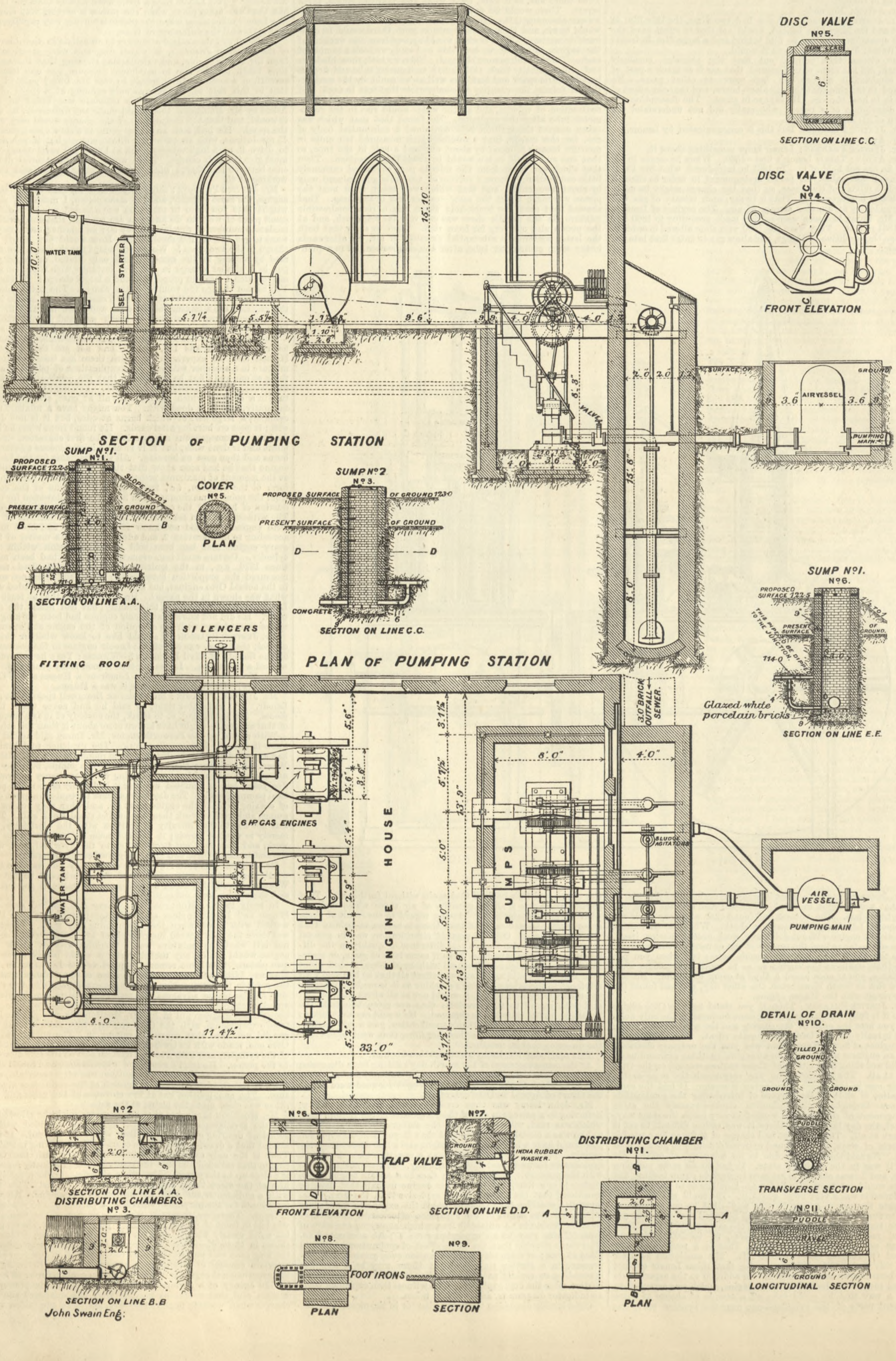
In reply to Mr. MOULTON, Mr. Imray said he had seen the Hugon and Lenoir engines at South Kensington, and that they worked with shock when they were doing any work. When he was there the man altered the richness of the charge, but he could not tell what the mixture was. Working without shock the engine would not do any useful work; it would barely move its own piston. The same remarks applied to the Lenoir as to the Hugon. With reference to the question of the arrangement of the gases in the Otto engine, he did not exactly agree in the view that as the piston advances the residuum will follow the piston and the charge come behind it. Approximately it would. He thought the diagram put in by Mr. Moulton was wrong. He had tried experiments with the Otto engine, which showed that the gas did not take that course in coming in. The engine was an Otto one, made with its ignition port in the regular way at the end of the cylinder, and with a second ignition port at the side close up to the piston. He tried a number of experiments, and found that when he ignited at the side the ignition was very uncertain, and often it failed, whereas when he ignited at the end it was always sure. The one ignition was at the entrance of the gases and the other was close up to the piston at the side.

Mr. MOULTON here asked that his witnesses might be allowed to see the arrangement of the slide. If he was provided with a sufficient drawing of it perhaps that would do instead. It was settled that a drawing should be in court on the following morning. That is the only experiment witness had made with the Otto engine that satisfied him that the residuum was practically remaining close up to the piston. The other experiment which satisfied him of the same thing was with the Sterne engine. This was with a eudiometer and with the ordinary Clerk engine. Air was introduced for the purpose of expelling a portion of the residuum in front. Therefore, naturally when the portion of the residuum was left in front of it, the air took its place behind it, showing to his mind clearly that it was not the perfect mixture which is shown in those diagrams. He presumed that the arrangement of the long cone was put specially by the inventor, in order to keep a certain amount of arrangement of stratification. Referring to the experimental engine in which the piston could be worked loose by the agency of a spring, so as to sweep out all the products, witness said that as far as possible they had compared similar charges when working in the Otto way, and then the piston was

THE STRATFORD-ON-AVON SEWERAGE WORKS.

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

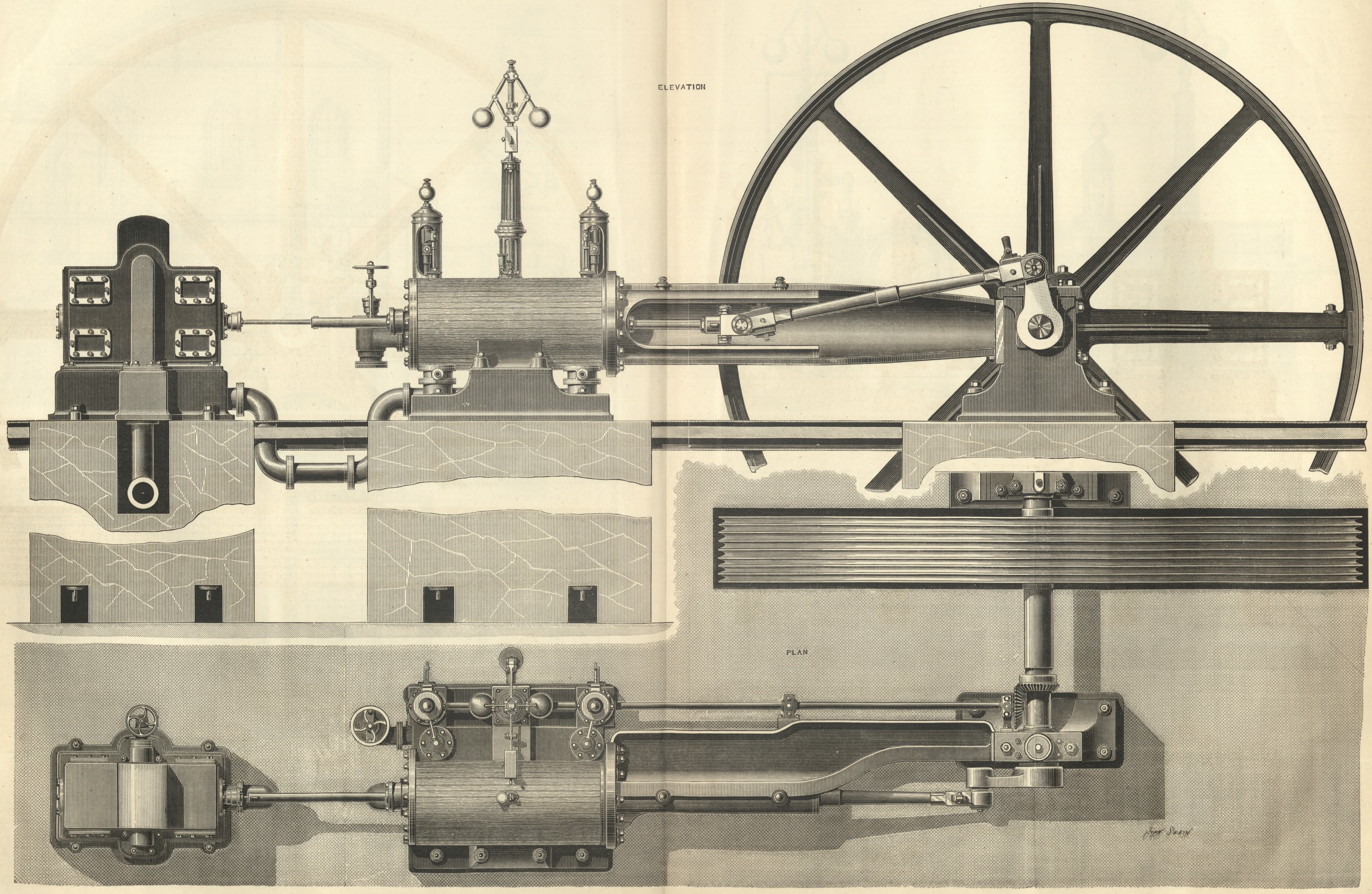
(*For description see page 9.*)



CONDENSING ENGINE, 120-HORSE POWER, ANTWERP EXHIBITION.

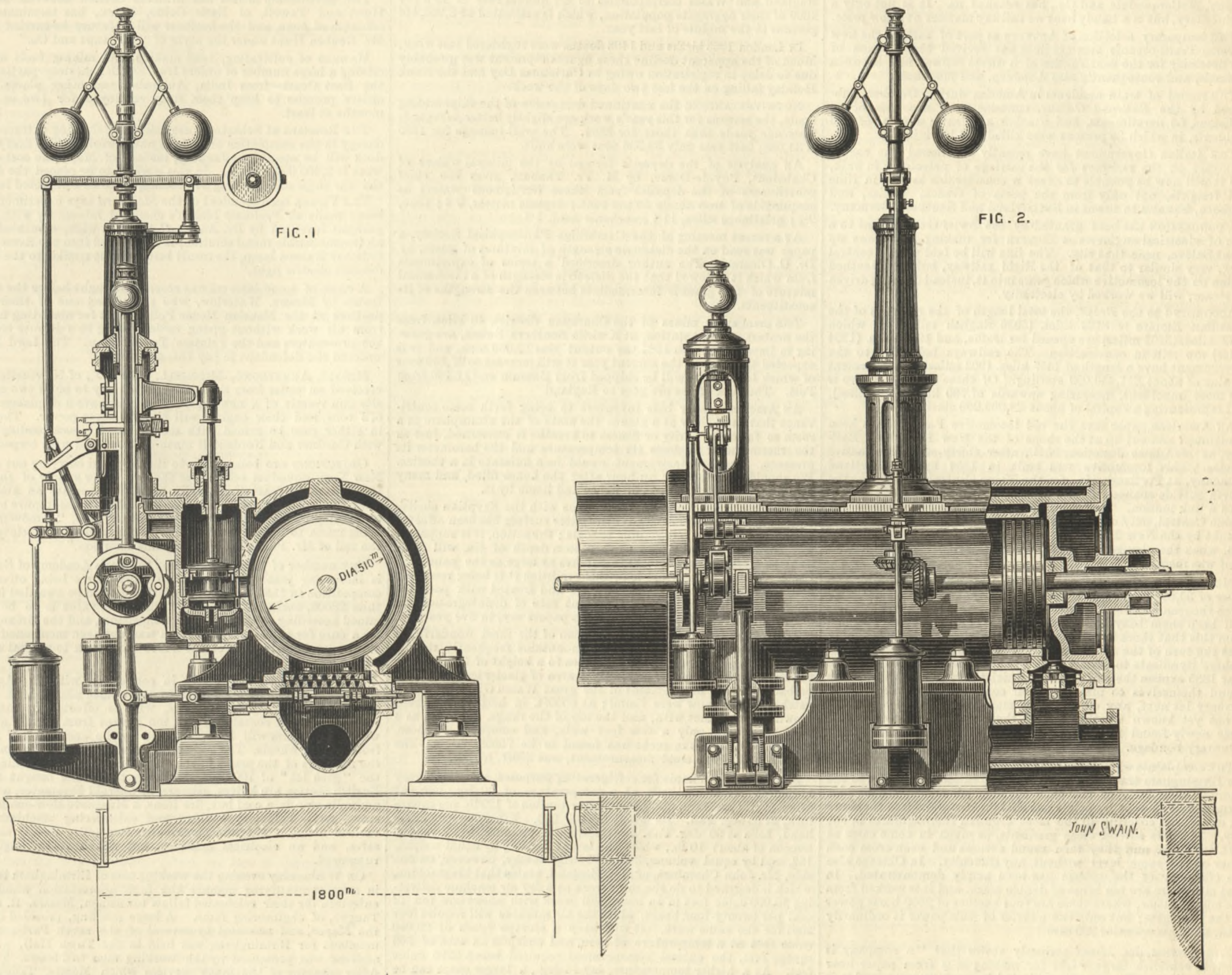
MONS. CHARLES NOLET, GHENT, ENGINEER.

(*For description see page 9.*)



DETAILS OF CONDENSING ENGINE, ANTWERP EXHIBITION.

M. CHARLES NOLET, GHENT, ENGINEER.



sweeping out products. He did not know whether 7 to 1 was a proportion they had tried, but had used 8 to 1. To one portion of coal-gas in the one case there was only eight of other gas, which was oxygen and nitrogen. In the other case there was one portion of coal-gas to the eight of oxygen and nitrogen, and to the three or four of residuum. He did not consider this altogether a fair way of comparing the working of the two engines. He had also counted the number of charges that were taken and the number of cubic feet of gas consumed, and ascertained as nearly as he could the quantity of gas per stroke in each case, and the result of that quantity of gas. It was found to be more economical to leave in the residuum.

Mr JUSTICE PEARSON: If I understand the case at all, according to what we have been told, we have not heard the other side, Lenoir desired, as far as he possibly could, to get rid of residuum. I am told that Lenoir thought the presence of residuum in the cylinder was an evil which you had to avoid if you possibly could. Accordingly, if this experiment was tried in one case effecting that which Lenoir said ought to be effected, in the other case leaving the residuum in, was it not a fair experiment to test the difference between the two, between what Lenoir would have called a perfect engine and what Otto says is a perfect engine?

Mr. MOULTON: No, not the least, and I think I can explain it to you in an instant, because Otto is keeping the residuum; he has a very rich charge, because he is going to get inert gas from the residuum. Lenoir was not going to use the residuum, excepting to a certain extent, to which I will call your attention. The consequence was he brought in his inert gas with his charge. Otto therefore works with 8 to 1, knowing he is going to fill it up with residuum. Lenoir worked with 11 to 1, and the 11 to 1 charge will work just as well.

Mr. JUSTICE PEARSON: It is practically the same.

Mr. MOULTON: It is the same thing, but in this case the comparison is with an 8 to 1 charge.

Mr. JUSTICE PEARSON: There is this enormous difference between them to my mind—I may be wrong—that Otto's charge will, so to speak, explode, and Lenoir's will not. You know what I mean. I mean that Otto's charge being very much richer than Lenoir's, it will be explosion, comparatively speaking, in Otto, and it will be ignition in Lenoir's.

Mr. MOULTON: Of course, that is my case. It is because in the Court of Appeal they decided it was explosion in Lenoir's and slower combustion in Otto's that they supported the patent.

Mr. JUSTICE PEARSON: I am leaving out all question of the residuum being there. I am looking simply at the charge when I am speaking of the two. I am leaving out altogether the fact that Otto puts in the residuum which, as he says, has a totally different effect.

Mr. MOULTON: Your lordship must not forget that Otto also claims leaving in air or drawing in air, and of having a residuum. The only difference is that in the Lenoir you took the 11 to 1 in at once, supposing that it was not drawn in, and leaving out of consideration the other point about Lenoir. In Otto, where you do not have the residuum, you draw in the 3 of air, and then you draw in the 8 to 1. And it becomes, as I shall show your lordship, 11 to 1 in the cylinder, and there is no difference whatever.

Mr. JUSTICE PEARSON: That, of course, I have to be told yet. I have not been told yet. Assuming for a moment the 8 to 1 separate from the 3 of air, you have all the difference between a diluted charge and a charge that is a strong charge.

Mr. MOULTON: Quite so. Your lordship has got exactly what I wanted to bring your mind to.

Mr. ASTON: I should like, with your lordship's permission, to say a word with reference to the way Mr. Moulton is putting this. He is assuming that in the Lenoir you get all the gas and air which forms his charge mixed to form the charge, which is quite correct. He makes the same assumption with reference to Otto—I do not take his figures, but assuming his figures are correct—that you have in an Otto an 8 to 1 charge, and in front of that a 3, which is a separate thing in the form of a cushion. He assumes the 8 to 1 plus 3 was unmixed.

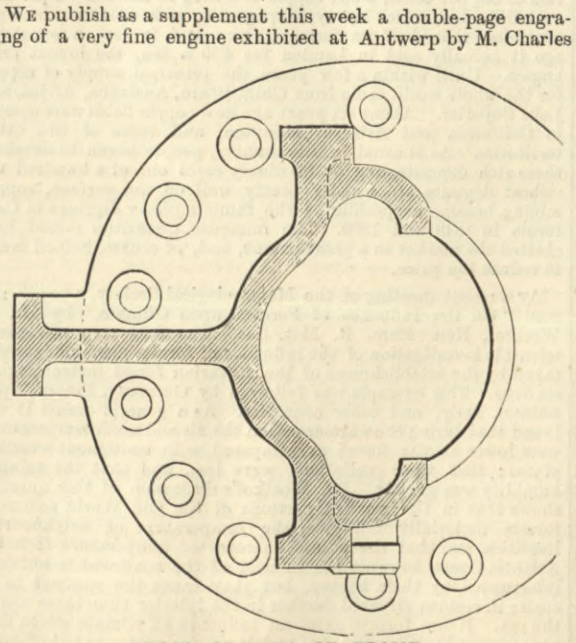
Mr. MOULTON here interposed, and said he proposed calling Mr. Fletcher, from the British Museum library in order to prove the publication of Beau de Rochas. This witness stated that the pamphlet, which was a thin one, was found in the room of the keeper of the department. It had been duly catalogued and had been in the library for many years. It was catalogued in January, 1864, and it would have been placed upon the shelves as quickly as possible afterwards. It would have been catalogued under Beau de Rochas only.

Cross-examined by Mr. ASTON, the witness said the work could only have been obtained by a person asking for Beau de Rochas.

Mr. ASTON then said he should ask his lordship to hear him say that was not a publication under *Plimpton* v. *Spiller*.

CONDENSING ENGINE, ANTWERP EXHIBITION.

WE publish as a supplement this week a double-page engraving of a very fine engine exhibited at Antwerp by M. Charles



CROSS SECTION OF FRAME.

Nolet, of Ghent. We have already on more than one occasion spoken highly of M. Nolet's engines, especially in our impressions for the 21st of March, 1873, and the 28th of March, 1879. It is only necessary to say that in design and workmanship the engine which we now illustrate fully maintains M. Nolet's high reputation as an engineer. The engine illustrated indicates 123-horse power, and gives out 110-horse power effective, with a boiler pressure of 75 lb., and a cut-off at one-sixth of the stroke. The piston is 20in. in diameter and 3ft. 3¾in. stroke. The fly-wheel is 18ft. in diameter and grooved for eight ropes. At the Antwerp Exhibition it was employed in driving a large roller mill, shown by M. Luther, of Brunswick—the mills by Ganz and Co.—capable of turning out 500 sacks of flour per day. The engine was exhibited *hors concours*—that is to say, it did not compete for a prize, and was sold to MM. A. and N. Buysse, millers, of Wettern.

Our engraving will, we think, suffice to make the construction of the engine very clear. The cylinder is carefully jacketted, and the valves are all worked by cams on a horizontal shaft driven by bevel gear. The exhaust valves are of the gridiron type. The steam is actuated by double-beat puppet valves, as shown in the cross section. The trip gear is extremely simple. A detent actuated by a spring engages with a vertical rod. The detent is carried by a frame, which is lifted by the cam on a rotating shaft. The vertical rod is provided with an arm, to which is secured the valve rod. The governor controls an inclined lever, on the end of which is a toe. This toe comes in contact with the trigger of the detent before referred to, and pulls it down as soon as the frame has reached a given height, or more strictly, it prevents the trigger from continuing to rise with the frame. This pulls the catch out of the vertical rod, and allows the valve to drop and so close. The angle of inclination of the toe-carrying lever is settled by the governor, which thus controls the ratio of expansion. An examination of the cross section through the cylinder will make this quite clear. It will be seen that M. Nolet does not believe in rotary valves, such, for example, as those employed by M. Bolinckx, and recently illustrated in our pages.

M. Nolet's first patent was taken out in 1867, and since that time he has made steam engines indicating a gross horse-power of 27,000. The largest he has made indicates 1500-horse power. It has a single cylinder 53in. diameter. This is believed to be the most powerful single-cylinder engine at work on the Continent. It drives the spinning mill of M. J. Hemptinne, in Ghent. The power is transmitted from the engine to the various floors of the mill by nine fly-wheel pulleys.

The engine exhibited at Antwerp furnishes another example of the great perfection to which Belgian engineers have carried the art of steam engine construction.

STRATFORD-ON-AVON SEWERAGE WORKS.

ON page 8 we publish the first of a set of engravings illustrative of the Stratford-on-Avon Sewerage Works, a description of which, with further engravings, will be published in an early impression.

RAILWAY MATTERS.

IT is said that a contract has been signed in Brussels, giving the concession for the construction of a railway connecting the Upper and Lower Congo, to the Congo Railway Company, of Manchester.

THE "Railway Diary and Officials' Directory," published by Messrs. McCorquodale and Co., has reached us. It is not only a useful diary, but is a handy book on railway matters at a low price.

THE temporary selection of Antwerp as port of call for the new German Trans-oceanic steamer lines has revived the question of the necessity for the construction of a direct railway line between Brussels, and consequently also Antwerp, and Mayence.

THE record of train accidents in America during October, published by the *Railroad Gazette*, contains brief accounts of 62 collisions, 55 derailments, and 6 other accidents; a total of 123 accidents, in which 36 persons were killed and 134 injured.

THE Italian Government have recently sanctioned the use of tank-cars on the railways for the carriage of petroleum in bulk, and it will now be possible to effect a considerable saving in time and freights, not only from the ports of Genoa, Venice, and Leghorn, but also to towns in Switzerland and Southern Germany.

A CONCESSION has been granted by the Swiss Government to a firm of electrical engineers at Geneva for making a railway up Mont Salève, near that city. The line will be laid with a central rack, very similar to that of the Righi railway, but the toothed pinion on the locomotive which gears into it, instead of being driven by steam, will we worked by electricity.

ACCORDING to the *Brésil*, the total length of the railways of the Brazilian Empire is 8123 kilos. (5036 English miles), of which 6132 kilos. (3802 miles) are opened for traffic, and 1991 kilos. (1234 miles) are still in construction. The railways belonging to the Government have a length of 1457 kilos. (903 miles), and represent a value of about £11,440,000 sterling. Of these the Don Pedro is the most important, measuring upwards of 700 kilos. (434 miles), and representing a capital of about £8,000,000 sterling.

AN American paper says the old locomotive Portland has been condemned and cut up at the shops of the New Brunswick Railway, at McAdams Junction, N.B., after thirty-one years' active service. This locomotive was built in 1854 by the Portland Company, at Portland, Me., for the Maine Central Road, being the fourth outside connected built at those shops, and one of the first with a link motion. This engine ran for a number of years on the Maine Central, only once receiving extraordinary repairs. She was bought by the New Brunswick and Canada Company some years ago, when the change from 5ft. 6in. to standard gauge on that road was made.

MESSRS. BOLCKOW, VAUGHAN, AND CO. have recently obtained an order of 30,000 tons of steel rails for India, as well as an order for some thousands of tons of steel sleeper plates. These two contracts will keep them busy for some months. It must not be assumed from this that there is any revival in the steel trade, but merely that the turn of the above company has come round for the Railmakers' Syndicate to permit them to have a good order. With the year 1885 expires the period during which the combined rail-makers bound themselves to maintain their combination. On and after January 1st next, any one of them may give notice to retire. It is not yet known whether any of them will avail themselves of their newly-found freedom, or whether all will still prefer their voluntary bondage.

THE complaints which have been made against the use of steam on the Birmingham tramways is directing attention once again to the reputed superiority of the cable system. A correspondent in a Birmingham newspaper points out that in San Francisco there are six cable lines covering all the most crowded thoroughfares in the city. The cars ascend steep gradients, as much in some cases as 78ft. in 412ft. and they turn round corners and even cross each other on the same level without any difficulty. In Chicago also the efficiency of the system has been amply demonstrated. In that city there are ten miles of double track, and it is worked from one engine house, where there are four engines of 2000-horse power in the aggregate; but only one quarter of this power is ordinarily used, and this operates 270 cars.

THE *Organe des Mines* seriously states that "a company is about to establish large works for making rails from paper near St. Petersburg. The paper is subjected to great pressure, and it is said that the material is extremely durable, and can be produced at one-third the cost of steel rails. A further advantage would be in their lightness, not only on account of the saving of the cost of carriage and laying, but also because they could be made in longer lengths than is the case at the present time, therefore the number of joints would be fewer, and consequently less oscillation to the carriages, and the wear and tear to both permanent way and rolling stock reduced to a minimum. A greater adhesion also would be offered by these rails to the driving-wheels of the engine, and the working expenses reduced accordingly." Nothing is said of greater rolling friction, or extra cost through frequent renewals.

A GENERAL classification of the accidents on the United States lines during October is thus made by the *Railroad Gazette*:—

	Collisions.	Derailments.	Other.	Total.
Defects of road	—	19	—	19
Defects of equipment	10	14	4	28
Negligence in operating	42	8	—	50
Unforeseen obstructions	10	5	2	17
Maliciously caused	—	2	—	2
Unexplained	—	7	—	7
Total	62	55	6	123

Negligence in operating is thus given as the general cause of 41 per cent. of all the accidents, defects of road causing 15½, and defects of equipment 23 per cent. A division by classes of trains and accidents is as follows:—

Accidents	Collisions.	Derailments.	Other.	Total.
To passenger trains	7	15	3	25
To a passenger and a freight	10	—	—	10
To freight trains	45	40	3	88
Total	62	55	6	123

This shows accidents to a total of 185 trains, of which 42—23 per cent.—were passenger trains, and 143—77 per cent.—were freight trains. Of the total number of accidents, 70 are recorded as happening in daylight and 53 at night.

THE United States is now sending abroad about £600,000 worth of locomotives per annum, the total value of those exported in the last fiscal year being £563,989. This, at an average of £2000 each, represented about 290 engines. In the fiscal year ended June 30th, 1882, the number of engines shipped did not exceed 133, the estimated value being 1,455,717 dols. Of the 282 locomotives exported from the United States in 1883-4, 65 went to the Argentine Republic, 49 to the United States of Colombia and Panama, 34 to Mexico, 32 to Brazil, 27 to the Dominion of Canada, 19 to Chili, 14 to Australia, 13 to Central America, 14 to Cuba, 6 to Spain, 3 to San Domingo, 3 to Sweden, 2 to Venezuela, and 1 to England. The number shipped in the fiscal year ending June 30th, 1881, was 99; in the year 1882, 133; in the year 1883, 219, and in the year ending June 30th, 1884, 282. During the ten years ending with June 30th, 1884, the Americans sent 434 locomotives to various parts of South America, 203 going to Brazil, 84 to Colombia, 72 to the Argentine Republic, 37 to Peru and 31 to Chili. During the same period of ten years Canada and British Columbia imported 208 American locomotives valued at £381,626; Mexico 167, valued at £361,740; Australia 113, valued at £215,834; Cuba 88, valued at 772,911 dols.; Russia 58, valued at 778,500 dols.; Central America 22, valued at £21,644; and Turkey 12, valued at £36,400. It seems very remarkable that countries oppressed with heavy protective duties should be able to compete so successfully with free trade England. Political economists would do well to supply an explanation.

NOTES AND MEMORANDA.

IN Greater London, last week, 2464 births and 1763 deaths were registered, corresponding to annual rates of 24·7 and 17·7 per 1000 of the population.

THE deaths registered last week in twenty-eight great towns of England and Wales corresponded to an annual rate of 12·3 per 1000 of their aggregate population, which is estimated at 8,906,446 persons in the middle of last year.

IN London 1965 births and 1408 deaths were registered last week. Much of the apparent decline these figures represent was probably due to delay in registration owing to Christmas Day and the Bank Holiday falling on the last two days of the week.

NOTWITHSTANDING the continued depression of the shipbuilding trade, the returns for this year's work are slightly better as regards Tees-side yards than those for 1884. The total tonnage for 1885 is 34,088; last year only 30,336 tons were built.

AN analysis of the deposits formed by the mineral waters of Chabetout, Puy-de-Dome, by M. Fr. Thabuis, gives the chief constituents of the deposits from these ferruginous waters as sesquioxide of iron nearly 50 per cent.; organic matter, 9·4; lime, 2·2; gelatinous silica, 11·1; carbonic acid, 1·8.

AT a recent meeting of the Cambridge Philosophical Society, a paper was read on the dielectric strength of mixtures of gases, by Dr. C. Olearski. The author described a series of experiments from which it followed that the dielectric strength of a mechanical mixture of two gases is intermediate between the strengths of its constituents.

THE manganese mines of the Charapau district, 40 kilos. from the nearest railroad station, at Kwirila Southern Russia, are growing in importance. In 1884 the output was 12,050 tons, and it is expected that during the current year it will increase to 27,550 tons of which 16,400 tons will be shipped from Batoum and 11,100 from Poti. The bulk of the ore goes to England.

AN American paper bids inventors to bring forth some contrivance that shall show at a glance the state of the atmosphere in a room so far as its purity or fitness to breathe is concerned, just as the thermometer discloses its temperature and the barometer its pressure. Such an instrument would be a nuisance in a theatre. We should have to leave an hour after the house filled, and many people would be turned out of house and home by it.

THE air of New York does not agree with the Egyptian obelisk erected in Central Park. The entire outer surface has been affected by the weather and is beginning to scale; the action, it is supposed, had begun in Egypt. The surface to a depth of ½in. will come away in a semi-decayed state in patches as large as the palm of a hand. Where the surface is in this condition it is being removed, and the whole surface is being cleaned and treated with paraffine for future protection. At the present rate of disintegration the obelisk would be ruined, the American papers say, in five years.

THE Waiau Gorge is described as one of the most wonderful in New Zealand. On both sides the mountains frequently rise by a succession of steep, rugged precipices to a height of 3500ft. over the river. About 6050ft. high a small area of glacier ice was found, probably all that now remains of the great Waiau Glacier. Small patches of red snow were found; at 6500ft. in height permanent snowfields were met with, and the top of the range, described as a mere razor-back, only a few feet wide, and composed of loose, angular, and slab-like rocks was found to be 7500ft. high. The highest peak, by aneroid measurement, was 350ft. higher.

SPEAKING of ammonia for refrigerating purposes, a contemporary remarks: Ammonia boils at a temperature of 30 deg. Fah. at atmospheric pressure, and has a vapour tension of 120 lb. per square inch, at 65 deg. Fah. Its latent heat is 900. Ether, on the other hand, boils at 90 deg. Fah. at atmospheric pressure, has a vapour tension of about 10 lb., while the latent heat is, by equal weight, 162, and by equal volume, 369. Putting theory, however, on one side, Mr. John Chambers, of New Zealand, states that his machine, which is designed to do the same work as a dry air machine delivering 60,000 cubic feet in an hour, will work with about one ton of coal per twenty-four hours, while the air machine will require four tons for the same work. It will keep a storage space of 20,000 cubic feet at a temperature of zero, and occupies an area of 306 square feet, the cubical measurement required being 2295 cubic feet. At a higher temperature, say 15 deg., a larger space can be kept cool.

IT is somewhat interesting to note the ages of the various vessels wrecked during the year 1883-4. Not including collisions and foreign craft, disaster befell 302 almost new vessels, 302 to ships from three to seven years of age, 483 from seven to fourteen, and 992 from fifteen to thirty years old. As regards the casualties befalling old and very old ships, 402 vessels were between thirty and fifty years old, 41 between fifty and sixty, 20 between sixty and seventy, 10 between seventy and eighty, 9 between eighty and ninety, 7 between ninety and one hundred, and 6 were more than one hundred years old. The ages of 79 of the vessels wrecked could not be ascertained. Irrespective of collisions, 764 steamers and 2162 sailing vessels were wrecked on the coasts during the year. Of the 2613 British vessels which were wrecked, excluding cases of collision, 1385 did not exceed 100 tons burden, 679 were from 100 to 300 tons, 162 from 300 to 500 tons, and 387 were above 500 tons burden. As regards the 340 British vessels totally lost—not including collisions—42 were constructed of iron, 33 of them being steamers, and 9 sailing vessels; the rest were either of composite build or of wood.

WHEN silver was selling at 61d. per ounce and lead for £18 a ton, copper was selling at between £100 and £105 per ton. Since then silver has gone down to 47d. per ounce, a depreciation of 23 per cent. Lead is now selling at £12 per ton, which is a depreciation of 33⅓ per cent., while copper is selling in London—Chili bars—at £42 a ton, which is, say, 58 per cent., or in other words, 8 per cent. less than half its former price; and, in fact, a few weeks ago it actually sold in London for £39 a ton, the lowest price known. Until within a few years the principal supply of copper for the whole world came from Chili, Spain, Australia, Africa, and Lake Superior. About six years ago new copper fields were opened in California and Arizona, Montana, and some of the other territories. As is usual in this country, people began to develope these rich deposits, and as in ninety cases out of a hundred the richest deposits are usually pretty well on the surface, copper mining became as prolific as the famous placer diggings in California in 1849 and 1850. The immense quantities mined here glutted the market to a great extent, and, of course, helped much to reduce the price.

AT a recent meeting of the Meteorological Society, a paper was read "On the Influence of Forests upon Climate," by Dr. A. Woeikof, Hon. Mem. R. Met. Soc. The first step towards a scientific investigation of the influence of forests upon climate was taken by the establishment of the Bavarian forest meteorological stations. This example was followed by Germany, France, Switzerland, Italy, and other countries. As a general result it was found that during the warmer season the air and earth temperatures were lower in the forest as compared with contiguous woodless places; that their variations were less, and that the relative humidity was greater. Dr. Woeikof's discussion of this question shows that in the western portions of the Old World extensive forests materially influence the temperature of neighbouring localities, and that the normal increase of temperature from the Atlantic Ocean towards the interior of the continent is not only interrupted by their agency, but they cause the summer to be cooler in regions situated further in the interior than those nearer the sea. Hence forests exert an influence on climate which does not cease at their borders, but is felt over a greater or less district, according to the size, kind, and position of the forests. From this it naturally follows that man, by clearing forests in one place, and planting others in another, may considerably affect the climate.

MISCELLANEA.

WORKMEN have been engaged in removing the pavement and causeway of the Pont Neuf. It has been ascertained that the lower side of the bridge remains firm, and that the upper side only will require to be rebuilt.

THE partnership which has hitherto existed between Messrs. Hunt and Tawell, of Earls Colne, Essex, has terminated by effluxion of time, and the business will in future be carried on by Mr. Reuben Hunt under the style of "R. Hunt and Co."

MAKERS of cultivating, road making, and mining tools are receiving a large number of orders from South America—particularly the East Coast—from India, Australia, and other places. The orders promise to keep them fully employed for two or three months at least.

THE Russians at Sebastopol are said to be showing extraordinary energy in the completion of various naval works. The first Crown dock will be opened in January, instead of May; the cost of the work is 2,400,000 roubles. In this dock is to be placed the first of the war ships now building at Sebastopol, to be completed in May.

THE Vienna correspondent of the *Standard* says experiments are being made at Professor Lieben's chemical laboratory with a new gaslight invented by Dr. Auer. "A cotton wick, saturated with an incombustible metal solution, is introduced into the flame of an ordinary Bunsen lamp, the result being a light similar to the incandescent electric light."

A CASE of some interest was recently brought before the magistrates by Messrs. Waterlow, who prosecuted one of their compositors at the Mansion House Police-court for absenting himself from his work without giving notice, owing to a dispute between the prosecutors and the Printers' Trade Union. The Lord Mayor ordered the defendant to pay 15s. as damages.

MESSRS. ARMSTRONG, MITCHELL, AND CO., of Newcastle, have received an order from the British Admiralty to build two composite gun vessels of a new type. They will have a displacement of 672 tons, and their engines will be 1000-horse power. They will in either case be armed with six 5in. steel breech-loading guns, with Gardner and Nordenfelt machine-guns, and with torpedoes.

OBJECTIONS are being made to the proposed carrying out of the New York aqueduct scheme for the new water supply of the city. One interested party is actually trying to "create an alarm by alleging that the water in the proposed lake will be impure because of its depth," and the *Sanitary Engineer* says, "a movement is being made to induce the New York County Medical Society to be the tail of Mr. Potter's dog to wag this assertion."

THE number of prizes awarded by the Paris Academy of Sciences is increasing yearly, not less than thirty-three being offered for competition in 1886. The total of the sums to be awarded is more than £3000, exclusive of some of which the value is to be determined according to the merits of competitors, and the Bréant prize for a cure for cholera. Dr. Ferran was not even mentioned in the verdict, and the interest of the £4000 was given to several writers on the etiology of cholera.

THE drawing of the lottery in connection with the Antwerp Exhibition, which is appointed to take place next month in the Palais des Beaux Arts, Brussels, will be effected by means of six wheels, each containing the ten figures from 0 to 9; and the winning numbers will be determined by the succession of figures from the six wheels. The successive drawings will correspond with the numbers of the prizes in the official catalogue, beginning with the "gros lot" of 100,000f. Among the prizes bought in the English section are knives, scissors, an aneroid barometer, a piano, umbrella stands, a coal box, fire irons, a Musgrave slow-combustion stove, letter balances, washing and calendering machines, and various filters. Belgium contributes two office desks, six iron safes, and an electrical machine, but not a steam engine, as rumoured.

ON Wednesday evening the working men of Birmingham testified in a most gratifying manner the high appreciation which they entertain for their celebrated fellow townsmen, Messrs. R. and G. Tangye, of engineering fame. A large meeting, presided over by the Mayor, and attended by several of the seven Parliamentary members for Birmingham, was held in the Town Hall, when an address was presented by the working men to Messrs. Tangye. After speaking of the many services which Messrs. Tangye had rendered to the town, and of the great part which they had taken in promoting art education, as applied to the many trades and industries of the district by establishing a school of art, the address set forth that the opening of the splendid art gallery, second to none under the control of any municipality in the kingdom, and in the establishment of which Messrs. Tangye took a prominent part, afforded a fitting opportunity for the operative population to express their gratitude for the efforts which Messrs. Tangye had made to promote the well being and prosperity of the great mass of the people.

ACCORDING to an article by Gòbel—*Oest. Zeits. für Berg-u-Hüttenwesen*, 1885, s. 14—all work at the sulphur mines of Swoszowice is suspended, the present price of sulphur precluding their being carried on at a profit. The mine, two kilometres south of Cracow, was commenced as long ago as 1422. The workings are in the Jurassic formation. There are two layers of sulphur-yielding earth, each composed of a dark grey marly clay, through which the sulphur is distributed in the form of concrete masses, varying in size from 1in. in diameter to no larger than poppy seed. These beds are separated by a vein of fibrous gypsum fluctuating between three and six fathoms thick. The roof is of clay containing petrifactions, and enclosing lumps of sulphur weighing as much as 3½ lb. The total depth is about thirty fathoms. The sulphur yield averages 10 per cent. The smelting of the crude mineral is performed in gallery furnaces, the yield being approximately 6½ per cent. For some years past the product has been consumed locally for making carbon bisulphide, which is largely employed as a phylloxera cure throughout the grape-growing districts of the Austrian Empire.

SPEAKING of the "accidents" on the new Croton aqueduct, the *American Contract Journal* says:—"Ten men killed in three instalments in a little more than a week is a fearful record for any work, and it is time that some other body than a stupid coroner's jury paid attention to this fact. Five men were killed in shaft No. 3 on Monday of this week and two more in adjoining shafts on the next day, while the death of three men had already been recorded for the week before. The shaft in which the accident of Monday happened is 385ft. deep; instead of a regularly constructed cage, with proper guides and safety appliances to transport men and material up and down this shaft, an iron bucket was still being used, such as is ordinarily employed in shaft sinking. To prevent the bucket from striking the sides of the shaft in its long descent, a wooden cross-head running in timber guides was strung loosely upon the hoisting rope and was supposed to go down with the bucket until the crosshead struck supports near the top of the tunnel and there rested. On Monday morning while sending down five men of the day shift, this heavy crosshead, weighing some hundreds of pounds and wet with its ascent through the dripping shaft, froze fast in the grooves of the guide, during the twenty-five minutes that it was stationary at the top of the shaft, and when the signal was given, the bucket passed down without it, the rope running freely through the crosshead; none of the men around noticed this fact, but after the bucket had descended the shaft some distance, the vibration of the rope shook the frozen timber loose and it fell, struck the bucket attachment, broke it, or the rope, and the bucket and men were precipitated to the bottom with the fatal results mentioned. The coroner's jury complacently render the stereotyped verdict of 'came to their death by an accident of their own carelessness and negligence,' and this is about all the obituary the victims are likely to receive from that fatal neighbourhood."

FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

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

CONTENTS.

THE ENGINEER, January 1st, 1886.

PUBLISHER'S NOTICE.

**** With this week's number is issued as a Supplement, a Two-Page Engraving of a Condensing Engine,* 120-*horse power, at the Antwerp Exhibition. Every copy as issued by the Publisher contains this Supplement, and subscribers are requested to notify the fact should they not receive it.*

TO CORRESPONDENTS.

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F. W. P.—*We fancy that an advertisement in our columns might obtain what you want. We cannot suggest anything better. Such photographs as you require are scattered up and down the country. No collection of them, such as you want, exists.*

ANALYSING OIL.

(*To the Editor of The Engineer.*)

SIR,—Can any of your readers inform me how to distinguish with certainty pure olive or Gallipoli oil from the various mixtures of rape, &c., sold under these names? Also, address of one or two refiners, or merchants, who could be relied on? E. D.

Reading, December 29th.

TALL CHIMNEY CONSTRUCTION.

(*To the Editor of The Engineer.*)

SIR,—Your journal having an extensive circulation amongst engineers and builders induces me to ask to be allowed to put two or three queries respecting the construction of tall chimney shafts, viz.:—What advantage shall I have in using a portion of Portland cement in mortar, and how much cement, or proportion, to lime and sand? Will hydraulic lime give better results than ordinary lime? Which would be best to use in constructing flues to carry hot gases to chimneys, brickwork in cement, or brickwork in mortar?

I notice in Messrs. Bancroft's work "On Tall Chimney Construction," mentioned in THE ENGINEER a few weeks back, that some builders use ordinary lime, some hydraulic lime, and others chalk lime with a little Portland cement added. My object in writing is to ascertain which is best. T. S.

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THE ENGINEER.

JANUARY 1, 1886.

1886.

In making our annual review of engineering progress, the state of trade in the United Kingdom always demands mention first, as the full occupation of the ever-growing number of engineers depends on trade, and on the extent to which trade developments are making new engineering works necessary and enterprise hopeful. The opening up of new industries or new directions of enterprise cannot be chronicled as a feature of the past year; and capital has not been offered many either promising or sound adventures, and established trade has continued, as during the past few years, to be generally—but with many instances to the contrary—in a languid state, and the fainting fit seems to affect the greater part of the world. The misfortune of our competitors abroad in the want of trade in many industries is to some extent our consolation; but consolation is not satisfaction, and satisfaction cannot be felt whilst we believe we can see that trade might be better if the proper course were taken. In some respects we have ourselves as a nation to blame, and individually many manufacturers have themselves only to blame. With nations as with individuals, trade goes to those who have some speciality to offer—special in sort, quality, or price. For many years England had at least two of these in favour of most of what she exported; now lowness of price is the chief recommendation. Protection abroad has encouraged manufactures in many countries which were our best markets; but, with minor exceptions, these countries are still unable to compete with us in price. The result is that some of these countries, and notably within the past few years the United States, devote their energies to the production of the really good instead of the cheap, and in the sale of these they have succeeded much abroad and not a little in England itself. "The best is the cheapest," is an old cry, and is one which may be successfully used by a competing country in countries where people have grown tired of the cheaper English goods, and proved that cheap may be dear. "English" was synonymous with good, but the race in the rapid acquisition of wealth amongst the ever increasing number of English manufacturers caused the lowering of prices, and to some extent the unnecessary lowering of quality. Prices were lowered more rapidly than improved methods lowered the price of production. English makers thus brought themselves to the level of successful attack by others; an attack doubly successful at a period when faith in the quality of English goods had begun to lose its hold. Thus, to take American competition alone as an example, we find America supplying herself with every mechanical and hardware requirement; she does not want ours; she succeeds with high-class goods in some European markets that were ours, and those European countries are now better than ever able to make the cheaper kinds of goods. Thus, although Protection might be a bad thing in England for our manufacturers, it has fostered the manufacturers abroad enough to modify the whole course of our trade. We no doubt can make as good an article as ever we did; but that is not enough. We must make a better article than ever, and even with this we have in some markets to make buyers believe in our quality again. With the cheap articles we have also a battle to fight; for the rapid rise of new industries in small manufactures under Protection—as, for instance, in Germany—has accustomed the artisan class to changes in modes and method, and manufacturers are there not only able to introduce at once any new thing that is good, or will reduce prime cost, but they do it, and export goods to England, and sell even the Sheffield specialities in Sheffield shops at a lower price than Sheffield manufacturers can do it. In some cases this is the fault of the men, who are blind in their opposition to change in the way of doing things; but in others it is the fault of the manufacturers themselves, some of whom are ever ready to turn their back on a new invention rather than examine its merits, until they hear a German firm is saving 20 per cent. in the cost of manufacture of some such article as scissors by its means. German manufacturers are, moreover, ready to make to suit any market, and to accept a lower profit than most Englishmen deem necessary. To go to much larger things, it is the same in bridge work. If an English maker is asked to tender for a girder not quite of the sort he has been accustomed to make, he immediately wants to charge more, because the designer has presumed to make a change, which he thinks will give him a little trouble, or he refuses to tender. An American, on the contrary, will not object to a design simply because it is new, and does not suit the present arrangement of his drilling, punching, and shearing machines, but will immediately begin to think out the simplest way to suit himself and his plant to the job. Witness the numerous bridges recently built and building in Canada and elsewhere. Some of these are actually being built of Scotch open-hearth steel, the duty on which is as much as it would be on the bridge; yet the bridges are being made by Americans. The bridges are partly rivetted and partly pin bridges. They are made in American shops, and put together in their places. Tension bars have pin holes drilled in them, which are within a fiftieth of an inch of their proper distance centre to centre, though 40ft. to 50ft. apart. Some English builders would not like this exactness, but it is absolutely necessary in a pin bridge designed well, and not having in it a great unnecessary weight. A number of the Pullman type of cars for the Continent, and for a company with a large amount of English capital, are now being made in France, "because of the numerous details to which English makers and workmen are not accustomed and would not do without a lot of trouble." Hence French men get the work.

These are, however, only a few of the minor causes of our loss of trade; but the improvement in the competitive power of foreign manufacturers will continue to lessen the readiness of capitalists to embark in industries at home, unless we more readily adapt ourselves to necessary changes and make ourselves proof against being easily "cut out." Things are rather brighter than they were, and steel rails are again going to the United States, probably owing to the rapid wear which has been found to take place in large quantities of American rails. Hopes are entertained of trade in China, and all countries have their eyes open to this. Germany and America are both on the alert for the railway work, of which there is much promise there. Belgium looks more hopefully in the direction of Africa than we do, and we are paying about half the attention we should to improving our relations with our colonies. It may be some consolation to remember that as long ago as 1752, Parliament was petitioned by the trading classes against the Hudson Bay Company, on the ground of a harmful monopoly likely to lead to Free Trade and increase the depression in trade, which they said was so bad because they had meet severe competition from all parts of the world.

Few years have, during the past half century, passed away carrying with them the records of so little completed civil engineering work. In England a train has been run through the Severn Tunnel, but it has not been opened for general traffic, although it will on the 5th inst. be four months since the informal preliminary opening took place.* Arrangements have been made to commence running coal trains on the 9th inst., direct from Wales to Southampton. The Act for the construction of the tunnel was obtained in 1872. Between that date and October, 1879, the Great Western Railway Company sunk five shafts and drove about three miles of headings to prove the nature of the ground. The headings under the river were within 130 yards of meeting when the works were drowned out by the sudden breaking in of a large land spring on the Welsh side, which completely filled the tunnel. The contract was then let to Mr. Walker, who erected extra pumps, and by December, 1880, succeeded in draining the works, and from that time to the completion the work progressed steadily, with the exception of a few but great difficulties. The total length of the tunnel is 7664 yards. In October, 1883, the spring which originally drowned out the works of the Company was again tapped at a lower level. The volume of water on this occasion was 27,000 gallons per minute. The pumping power at Sudbrook when this happened was equal to 11,000 gallons per minute, and after three weeks' continuous pumping the water in the shaft was lowered sufficiently to show that after the first rush the pumping power was equal to the supply. This water had to be built out of the Tunnel by heavy brickwork headwalls, and extra pumps were erected of sufficient capacity to deal quickly with the greatest flow of the spring. The entrance to the tunnel on the English side is through a cutting $1\frac{1}{2}$ miles long and 60ft. deep at the deepest end. The entrance to the tunnel on the Welsh side is also through a cutting about one mile long and 60ft. deep at the tunnel mouth. As both these cuttings lie in the marsh-lands adjoining the river Severn, heavy sea banks have been tipped to prevent high spring tides from entering the tunnel. The brickwork with which the tunnel is lined varies from 3ft. to 2ft. 3in. in thickness; it is built of vitrified bricks set in Portland cement mortar. Sir John Hawkshaw is chief engineer, with him is associated Mr. Charles Richardson, of Bristol, who prepared the plans for Parliament, and commenced the work. Mr. A. G. Luke, as resident engineer, represented Sir John Hawkshaw.

The Mersey Tunnel† has been completed. A train was run through it on the 21st ult. It was inspected on Tuesday last by Major-General Hutchinson, and will be formally opened on the 29th inst. by the Prince and Princess of Wales. Mr. James Brunlees and Mr. Chas. Douglas Fox have thus completed a difficult undertaking, and will, with the contractors, Messrs. John Waddell and Sons, deserve the credit and praises which will be bestowed upon them on the 29th.

The ship canal between Cronstadt and St. Petersburg was opened on the 27th May last.‡ It is seventeen miles in length and 22ft. in depth, with a width of from 180ft. to 240ft.

Germany has decided upon constructing a North Sea and Baltic ship canal, and the Reichstag will soon be asked to vote the money for it. In referring to the project the Berlin *Post* says:—"Prince Bismarck is not the first statesman who devised a waterway between the German Ocean and the Baltic available for war and trading vessels of the largest size. At the time when Wallenstein's 'Grand German' schemes seemed to be near their execution, this statesman, who among his other dignities was appointed Imperial Admiral, cast about to establish a German sea power on the Baltic, and conceived the idea of uniting both German coasts by a canal running through Schleswig-Holstein. But with the other high-flying plans of Wallenstein, this idea came to nothing, though it was shortly afterwards taken up by Cromwell, who, when Protector, in close alliance with Sweden, aimed at securing to England by this enterprise the hegemony of the Protestant nations of Northern Europe. His plan indeed went so far that the line of the projected waterway was actually fixed. Leaving the Elbe, the canal was to follow the Eider, and passing through the Lake of Schwerin, enter the Baltic near Wismar; which would thus be converted into a kind of Northern Gibraltar. But technical difficulties delayed the commencement of the enterprise, and death snatched away the mighty man before he succeeded in removing the difficulties that stood in his way."

The Manchester Ship Canal Company is before Parliament asking for powers to pay dividend out of capital during construction. Although a start has been made in the work of constructing the canal, the scheme is even now causing wrangling among some of its warmest supporters before Parliament. The proposal to pay dividend out of capital is likely to raise something of a controversy before the Committees. But the Salford Corporation is also promoting a Bill to amend the Canal Act in various ways, and over this measure there is a good deal of soreness where all have been supposed to be in accord. The chief feature of this Salford Bill is a provision authorising the Corporation to take a quarter of a million of pounds worth of shares in the canal undertaking, and this proposition caused a lively and not quite creditable scene in the council-chamber a few days ago. The Corporation having some time back passed a resolution in favour of such power being asked for, a special meeting was called to confirm—or reject—that resolution. On the proposal to confirm the resolution being made, opposition was at once presented, and before the meeting

* THE ENGINEER, 11th September, 1885; 26th September, 1884.

† THE ENGINEER, 2nd January, 1885, p. 10; 14th August, p. 124; 7th December, 1883, p. 450.

‡ THE ENGINEER, 29th May, 1885, p. 427.

was over a good many councilmen had gratuitously bestowed new names on each other. Ultimately, although urgency was pleaded, and the meeting was as full and representative as could well be secured, the matter was adjourned for a week. These proceedings are not calculated to raise the credit of this body of councillors, and they may prove troublesome to the promoters of the canal.

The Panama Canal work is still proceeding; but without actually visiting the works, it seems almost impossible to obtain facts concerning it. American papers when they print original information condemn the whole thing, say that but a comparatively small amount of work has been done at great cost, and that financial difficulties of an insuperable kind stare the company in the face. The book* by Mr. J. C. Rodrigues, LL.B., gives a most unqualified condemnation of the whole of the work done, the way of doing it, the money expenditure, and the state of the finances of the company. He says that the quantity of work done and to be done have both been falsely stated, and that much of the costly dredging and excavating plant sent out has turned out useless. In 1883 the company had used over eight and three-quarter millions sterling out of the estimated cost of twenty-four millions, or about 37 per cent., and had done about 1 per cent. of the excavation work. French papers generally take blindly what M. de Lesseps tells them; but the *Economiste Française* says that unless the company is thoroughly reorganised, "we shall see the most terrible financial disaster of the nineteenth century." The *New York World* sent Mr. Rodrigues specially to report on the work; and although we may allow something for American antipathy to the project, it must be remarked that the publications of this paper, and others that have not simply copied French journals, have supported the statements of Mr. Rodrigues.

The project for constructing a ship railway across Panama —or rather Tehuantepec—is still seriously entertained, and a lengthy paper or address was read before the American Association for the Advancement of Science in August last, by Mr. E. L. Corthell, who is associated with Mr. Eads. Several men of note have given their names to the scheme, but it does not seem probable that this will attract capital.

The Channel Tunnel project is again to come before Parliament. Power will be sought to enable the South-Eastern Railway Company and the Submarine Continental Railway Company, and any other body or company, to maintain, enlarge, and extend for experimental purposes the existing shafts and borings already executed by them upon the foreshore at Hougham, Kent, and in, through, and under the bed of the Straits of Dover, "with a view to ascertain and determine the practicability of making and maintaining a tunnel for railway purposes beneath the Straits of Dover between England and France." The Bill will make provisions for "the event of the said experimental Channel Tunnel works proving successful, and provides that those executing them or any permanent Channel Tunnel works, might within ten years from the passing of the intended Act, "be required to sell and transfer the same to the Lords of the Treasury, or as the Bill may prescribe, upon such terms as may be agreed upon, or, failing agreement, as may be settled by arbitration," and for enabling the South-Eastern Company to apply to and raise capital for the purposes of the Bill; and to amend section 14 of the South-Eastern Railway Act by increasing the amount thereby authorised to be expended for the purposes therein mentioned.

Sir E. Watkin has great faith in the idea that capitalists are burning to let him show them how to spend money on this job.

The great Forth Bridge—the largest structure of the kind at home or abroad—has been so fully dealt with by us during this year,† in descriptions of the bridge and its progress, as well as of the machinery employed in its construction ‡ and the mode of erection, that we need do no more here than describe the recently completed work. At South Queensferry, the lower built-up bed steel plates have been fixed on the two south main piers, which are therefore now ready for the superstructure. The north-east pier is practically finished. The tilted caisson for the north-west pier was successfully floated on the 19th October, when she was moved southward into her proper position. The mud having been cleared out of the inside, a brick wall was commenced on top of the sound concrete between the skins, round the whole circumference of the caisson. This brickwork is now in progress, and will be carried up so as to close the cap in the ironwork, and protect the concrete where it would otherwise have been exposed to the water. The weight of the brickwork, together with about 400 tons of concrete which have been added in the centre compartment, have been sufficient to prevent the caisson floating again, and accordingly air pressure was applied on the 25th Nov., and men are now daily at work clearing away the mud in the tubes and air chamber. The process of sinking may therefore be said to have fairly commenced. Nothing further has been done to the Viaduct piers, but the seventeenth span of the girders has been completed. At Inch Garvie the lower bed-plates of the main piers have been fixed on the two north piers. The south-east pier is complete except that a few of the capping stones are still to be set. The south-west caisson reached its final depth on the 2nd October, and the concrete having been carried up to low-water level, the masonry has been commenced and has already reached tide level. A commencement is now being made with the erection of the horizontal compression tubes between these piers. At North Queensferry all four main piers are ready for the superstructure. The cantilever pier remains at the same level as in September, but the Viaduct piers have been raised about 8½ft. since the raising of the girders was commenced, but nothing is being done at this part of the work at present, as there is no necessity for pressing this section during the winter months. Of the superstructure both the horizontal tubes between the north and south piers of the main group have been erected, and about 30ft. in length of one of them have been rivetted up. The top bed-plate of the north-west pier has been rivetted up, and the skewback is now being erected on the top of it. The top bed-plate of the north-east pier is also being erected. Altogether about 293,000 cubic feet of granite have been delivered up to date, of which 254,000 cubic feet are set; about 84,720 cubic yards of rubble masonry and concrete are in position, and 15,000 tons of cement have been used. The twelve great skewbacks are now in progress of construction or erection. As already indicated, those for the two Fife north piers are in process of erection; the other two for Fife are nearly ready for removal to the piers. The four for Queensferry are well advanced, and those for Inch Garvie have been commenced. Including the horizontal tubes for Fife and Garvie now being erected 2300 lineal feet of tubes of 12ft. diameter have been drilled, and 2000 lineal feet of 8ft. tubes. Of the lattice tension members about 3300 lineal feet are ready for erection, and the top junctions for Fife and Queensferry are about half finished; 18,200 tons of steel have been delivered at Queensferry, including 2500 tons for viaduct spans. The number of men employed on the works averages about 2000.

The most curious looking bridge ever built is now in course of construction by Messrs. Westwood, Bailey, and Co., for crossing the Indus at Sukkur.* In design it is a cantilever bridge, 790ft. span, and looks like a couple of special jib cranes supporting a central girder of 200ft. It is a sort of caricature of the Forth Bridge.

There is one question concerning bridge structure and bridge material upon which action should at once be taken by the proper authorities. We refer to the Board of Trade rules with reference to wrought iron and steel bridge structures. In the commencement of this article reference has been made to the decline of English bridge work where American builders have any chance of competing. Indirectly it may be fairly contended that this is to some extent the result of the English Board of Trade rules for railway bridges. The rules, as they now stand, are not only perfectly useless for securing safety, but they indirectly put a premium on bad materials. This, taken with the fact that a Board of Trade inspection of a bridge must remain a farce so long as these rules are in force, places the public safety completely in the hands of the bridge engineer or of the resident engineer, or inspector representing the engineer on the work. A bridge that would be passed by the English Board of Trade would require strengthening 5 per cent. in some parts and 60 per cent. in others before it would be passed either by the German Government or by the leading bridge building companies in America, and yet it is known that most of the German or American bridges have a lighter appearance than our own. The Board of Trade rules demand only that there shall be a square inch of section for every 5 tons stress if of wrought iron, and of 6·5 tons if of steel. Thus any material, however rubbishing, may be employed. Even if it have only a tensile strength of a fraction above these figures, it will be passed by the Board of Trade. Thus the safety of a bridge depends entirely upon the good faith and ability of the engineer to see that good material is used. There is no reason, except honesty, for putting good material into a bridge, and unscrupulous men will say common material is good enough when anything will pass the Board of Trade. There is no doubt that this feeling actuates bridge-building to a considerable extent; it encourages the continuation of unsatisfactory design and workmanship, and a result of years of working under this rule is that a system has grown up which it will not be easy to leave, and a disinclination to any but the good-enough policy is sufficiently widespread to make it really difficult for any engineer to get bridges built which are out of the ordinary run. "Bridge and girder angles and plates" in price lists of iron, heads the section devoted to an inferior kind or make of iron—a fact which alone shows the notions held concerning what will do for bridges. It no doubt often happens that thickness of plates is necessary for stiffness only, and not for strength, and for this a common brand will have the necessary qualities; but this only shows that the plate girder system is adopted where another system would be better mechanically and economically. In one recent case, which is typical of many, an engineer had designed bridges at considerable trouble, but, to suit the custom of the bridge makers' trade, he had to submit to an increase in weight, which changed his bridges from economical to ordinary bridges in this respect. He also endeavoured to work more on the German system of using lattice girders under 100ft. span, as well as above that; but the difficulty of getting light lattice girders built with sufficient care, instead of with that rough-hedge carpentering in iron which is about the quality of most plate girder work, was so great that he had to give it up, and return to the heavy ugliness of the plate girder. He had tried to get larger bridge girders made without plate work, and with greater depth, necessitating long tension bars, but the difficulty which has been experienced in getting these long bars made sufficiently accurately to length, so that one might not be sagging while its neighbour was being stretched under undue load is so great, that he will have to give up the attempt unless he makes his sections much heavier than is necessary except to cover bad workmanship. Now, this sort of thing is a daily-acted fact, but the chief American and Canadian bridge builders are accustomed to make lighter bridges, and there is no finer work done in the world than that they turn out at the present time. There is now about to be built a new bridge over the St. Laurence—a big bridge. It will be made of British steel in Canadian works. Hundreds of bridges have been made during the past few years for Canada, and we have made hardly any, if any, of them, although much of the material has gone from our shores, and paid as high a duty as it would have paid if our men had been paid the money to work it up into bridge forms. We lose trade in all directions by the stubbornness and inertia of our manufacturers, and it will probably be a long time before we can make many of the proprietors, foremen, and workmen in our bridge and girder yards understand that something more of the nature of an instrument of precision than a sledge hammer and drift may be used without great expenditure either of time or money in girder constructing; and that with suitable designs the drilling and boring machine may have to take the place of a blunt shearing machine, and punching machine with blunt punch and blunt edged die.

The rule to which we have been referring was useful in its day, and was adopted by the Board of Trade upon the recommendation of civil engineers. The Board is therefore not to be blamed for it, and steps ought at once to be taken by the Board to obtain the opinion of civil engineers who are amongst the leaders in modern practice; not of those who, though eminent as engineers, are beyond that age which admits alteration to be necessary in any rules they have long been accustomed to work with. If the rule for iron and steel girders were made more like that for cast iron girders, *i.e.*, framed so as to leave it to the engineer to make the best bridge for the work, the end would be obtained. If, for instance, a rule were made that a bridge should carry a breaking load equal to, say, five times the load it would have to carry, engineers would have more freedom in choosing and enforcing designs which would pay for extra labour by better disposition of materials. At the present time no rule or uniformity in practice prevails, and the circumstances and conditions of bridge building of to-day make rules that were eminently suited to their time unsuitable for the day. A greater factor of safety must in many cases be adopted than has been hitherto used, for it is proved beyond doubt that where the traffic on a bridge is great, the deterioration in strength bears a very decided relation to frequency of loading and unloading, although the burden may be small compared with the calculated breaking load.

The Board of Trade rule of 6·5 tons for steel has been relaxed in the case of the Forth Bridge, where 7·5 has been granted, but it is needless to say that, with what may be called 30-ton to 37-ton steel, this stress is not too heavy for general application, but it would be were it intended. In many parts, such as main members in tension, only about three-fifths of this stress will be visited upon the material; but as more than half of the 42,000 tons of steel which will be used in this bridge will be in compression, a higher stress may be visited upon it, and these differences in the apportionment of sectional area are the more satisfactorily arranged as a steel of from 30 to 33 tons tensile strength will be used for tensile members, while steel of from 34 to 37 tons will be used for compression members. In all cases of bridge design differential factors should be used instead of a slap-dash all-round factor, which in some parts of a bridge is too high, and in others as much too low.

Not long since we briefly referred to one of the points here raised in our "Railway Matters;" and an American paper, quoting our paragraph, adds the following:—"It is possible that our contemporary has just learned that our bridge-building firms are cutting English builders out of colonial markets not only for bridges of all 'ordinary sizes,' but many of extraordinary size. They have only themselves to thank for their Board of Trade rules. The past greater cheapness of their raw material has enabled them to substitute weight of metal for the scientific adaptation of sizes and shapes in use with us; and for a long time their products found sale under the name of British solidity of construction. But now that pig iron, Bessemer rails, and refined iron in bars is only 4 dols. to 5 dols. per ton, and common iron only 5 dols. to 6 dols. cheaper in England than here, and they are met with such statements as those lately made by Baker, that members of some English bridges would require strengthening to the amount of 60 to 160 per cent. before being up to American standards, there is no doubt about the cutting of their trade. The editor of THE ENGINEER should not have allowed the implication contained in the sentence 'for bridges of all ordinary sizes' to have appeared; for as long ago as the building of the Intercolonial Railway, Clarke, Reeves, and Co. got all the long and ordinary spans, the English builders securing only girders and structures not requiring trussing." The spans requiring accuracy of workmanship thus went to the Americans. We do not say this was of itself the sole cause.

A very fine steel cantilever built-out bridge was completed in September over the St. John River, at St. Johns, affording railway communication between the State of Maine and the United States, or generally between New Brunswick and Nova Scotia. The main river span is 477ft., supported on granite piers 9ft. by 27·5ft. at top, the higher one being 96ft. in height. From one pier 262ft. were built out. The centre girder supported by the cantilevers is 143·5ft. span. It is proportioned to sustain a train load of 1·25 tons per foot run, or two engines weighing each 45 tons and with tenders. It was constructed by the Dominion Bridge Company, of Montreal, of mild open-hearth steel, having an average ultimate tensile strength of 60,000 lb., or not quite 27 tons, and an elastic limit of 36,000 lb. The design was made by the chief engineer of the Dominion Bridge Company, Mr. J. Abbott.

London, it must now be supposed, is to have another eastward bridge over the Thames. The new bridge is to have a quaint architectural exterior sketched by Mr. Horace Jones, the City Architect, but the bridge is to be built from the designs of Mr. John Woolf Barry, who will, however, retain Mr. Horace Jones' suggested exterior, as the bridge is to be constructed under these two gentlemen jointly.

The contracts for the first part of the crowning work of Mr. J. F. Bateman, the Thirlmere water supply to Manchester, have been let. The first works will consist of about five and three-quarter miles of tunnelling, a mile and a-half of open cutting, and the masonry and other work connected with this. The first part of the work, of which an interesting account is given by Mr. Bateman in his book on the Manchester Water Supply,* will be a

* THE ENGINEER, November 13th, 1885, p. 379.
† THE ENGINEER, 11th September, and 9th and 16th October, 1885.
‡ THE ENGINEER, 16th and 23rd January, 1885.

* THE ENGINEER, 11th July, 1884; THE ENGINEER, 25th Sept., 1885.

* THE ENGINEER, October 9th, 1885, p. 283.

tunnel of nearly three miles in length, and 270ft. below the surface. The aqueduct is to be constructed to convey 50,000,000 gallons per day.

With the exception of a neat cottage, there will be no observable indication of the point at which the water is drawn from the lake—none, at least, which an ordinary visitor would recognise. On leaving the tunnel, the aqueduct will issue in the valley leading to Grasmere, keeping the high land above Rydal and Windermere, passing under Chapel Green, Nab-Scar, and Skelgill Wood. In this latter case, after two or three years, it will be hard to discover where the ground has been disturbed. Crossing Troutbeck by inverted iron syphon pipes, covered over with earth, it will be taken behind the residences of Hole Hird, St. Catherine's, and Elleray, by a tunnel, passing Windermere railway station, about two miles to the east. The valleys of the Kent, the Lune, the Ribble, and others, will be crossed by inverted syphon pipes, the rivers being passed over by bridges. When it reaches the neighbourhood of Bolton the water will be conveyed in cast iron pipes, mainly along public roads, to the existing service reservoirs of the Manchester Corporation, and then distributed to the inhabitants. There will be nearly thirty-three miles of 40in. cast iron syphon pipes, nine miles of 36in. piping, and, besides these, about eighteen miles of 33in. size.

The Liverpool Water Supply Works have lately been much before the public in a very undesirable aspect. The Water Committee of the City Council, at a meeting held on the 23rd October last, decided that Mr. G. F. Deacon, the resident engineer at the Vyrnwy Waterworks, should make a report to the committee as to the stability of the Vyrnwy embankment, and the manner in which the works are generally being carried out. This report has accordingly been prepared and submitted to the Water Committee. The report is at present denied to any but members of the Council, a course which seems very absurd when it is remembered that it must soon become public property. Mr. Deacon's report commences with a description of the precautions taken to secure the best materials and best conditions of their use for the dam, and he concludes by saying his report "is an investigation of the stability of a section of the masonry dam under certain extreme conditions towards which the facts tend, but which, in the nature of things, they cannot reach. When the reservoir is empty, the centre of pressure cannot approach nearer to the inner toe than four-tenths of the base, and, when full, it cannot approach so near to the outer toe as four-tenths of the base. This is the case even if the rock be conceived to be so porous that the full pressure of water from the reservoir intrudes beneath the dam to a distance of 40ft. from the inner toe. If, therefore, the material of the dam is capable of sustaining the tendency to crush, it is perfectly stable. When the reservoir is empty, the maximum pressure tending to crush the material occurs at the base near the inner toe, where its average value is less than nine tons per square foot. When the reservoir is full, the maximum pressure is transferred to the neighbourhood of the outer toe, where its average value is less than nine tons per square foot. The tests of Professor Unwin, C.E., and Messrs. Kirkaldy and Son, taken in connection with the mode of construction, show conclusively that the ultimate resistance of the materials of the dam to crushing, two years after construction, exceeds 150 tons per square foot. It is, I think, certain that every other vertical section of the dam is, in virtue of its design and construction, no less strong than the typical section adopted for the purposes of the calculation. In my judgment, the masonry dam under consideration is well suited to its purpose, and has an exceptionally high factor of stability, so high, indeed, that no doubt whatever as to its abundant sufficiency can be reasonably entertained." The appendices to the report contain reports by Professor Unwin as to the strength of stone and materials used in the masonry dam, and of Messrs. D. Kirkaldy and Son as to the strength of the materials.

An important addition to the New York water supply is being made by the construction of a new aqueduct from near the Croton dam to New York, by a line much more direct than the existing aqueduct, which is overtaxed. A new dam is to be built at Quaker Bridge, by which the available capacity will be raised to 32,200 millions of gallons, or sufficient to cover 9400 acres 9ft. in depth. The dam is to be of masonry, 178ft. above the river Croton bed, and below this the foundations will have to be carried about 100ft., making the total height for about 400ft. in length approach 300ft. The width at the base will be about 200ft., and its total length will be 1300ft. The aqueduct now being built has a maximum capacity of 320 millons of gallons per day, and its total length to the reservoir in the centre of New York is a little over thirty-three miles.

A big piece of submarine rock destruction for the improvement of navigation was completed by the blowing up of Flood Rock Hell Gate, New York Harbour, on the 10th of October,* by means of 270,000 lb. of explosive lodged in holes in about nine acres of honeycombed rock. Hell Gate was the scene of similar operations by which Hallet's Point was removed† on the 29th September, 1876.

One of the largest pieces of river-work now in hand is the Ribble improvement, in connection with docks‡ also in course of construction, under Mr. E. Garlick, Mr. T. A. Walker being the contractor. The river works will involve some miles of tipped rubble training wall and about two millions of cubic yards of dredging. Rapid progress is being made with the new bridge over the Tay,§ now being constructed under Mr. W. H. and Crawford Barlow by Messrs Tancred, Arroll, and Co. This and the Forth Bridge constitute two examples of expenditure of very large sums over very small areas, and both expected to earn a dividend on their great cost by a comparatively small saving of distance and time.

When we wrote at this time last year, the agreements as

* The Engineer, 9th and 16th October, 1885, pp. 273 and 304.
† The Engineer, 29th September, 1876, p. 217.
‡ The Engineer, 20th June, 1884, and 17th July, 1885.
§ The Engineer, 10th July and 25th September, 1885.

to the widening of the Suez Canal had recently been concluded and work was forthwith to be commenced; but although steamers with electric lights are now allowed to pass through a portion of the Suez Canal at night, which is a great gain, nothing is yet being done to widen the canal as agreed upon. It is understood in Alexandria that the delay is not caused by M. de Lesseps or the Council of Administration. Both are fully alive to the necessity of the work in the interests of the public, but unexpected difficulty is made by the Egyptian Government. The present width and depth of the canal are laid down in the original Khedivial concessions, and alterations in the statutes of the company are necessary before the canal can be widened. The Khedive withholds his consent; but as the consent of the Khedive depends upon Nubar Pasha, the will of the British Government ought to be supreme.

The canalisation of the Moselle is again attracting attention. The scheme has much in common with the Manchester Ship Canal. The Coblentz, Ireves, and several other Chambers of Commerce are strongly in favour of the project, but some others have not yet approved, and the Government have so far declined to undertake the project as it has been hoped they would. Failing this, efforts are to be made to form a company to carry out the work. The proposed river canal will be about 190 miles long, and while the first object is to make the river available for larger ships than can now get up, it is expected that great relief would be obtained in transit charges. It is said that unless this work is done and freights lowered thereby, the mining and iron industries of Westphalia will be ruined. The promoters' stories are the same all the world over.

Arrangements have been made with Mr. H. J. Marten for a survey to be made of the Grand Junction and Birmingham and Warwick Canals from Birmingham to London, for widening and deepening the canals to admit the traffic of 80 to 100-ton barges, to be either towed or worked by steam. The subject has frequently occupied the attention of local traders, and the Dudley Chamber of Commerce had before them on Monday the advisability of widening the canal between the Black Country and London. It was pointed out that iron sent to London by rail cost 15s. per ton, and that by boat the cost was 11s. 8d. or 12s. per ton. The widening of nearly 200 miles of canal, with 100 locks, would, it is urged, cost so much money that the difference in freight would never pay the interest on the outlay. In opposition to this view it was, however, remarked that by steam on the canal the present water freights might be reduced one half. A committee was appointed to consider the question.

The Tilbury deep-water docks, of which we have given particulars,* have been so far completed that water has been admitted. The first contract for this work is still the subject of arbitration. The new docks will accommodate any vessel afloat, with the exception only of the Great Eastern, and her paddles alone prevent her entering the dock. In the great tidal entrance basin, the water will rise and fall with the river, though there will never be a less depth than 26ft. at the lowest spring tide. It has an area of 19½ acres, and the depth will be 46ft. below Trinity high-water level. The water within the lock has a depth of 38ft., and the lock itself is 700ft. in length by 100ft. in breadth. There are three iron gates, which divide the lock into, practically, two locks 555ft. and 165ft. respectively, and these gates will be opened and shut by the aid of hydraulic engines. By the side of the lock are two large graving docks. These are closed by caissons, and are so arranged that in the event of anything going wrong with the lock, the graving dock could be used for the entrance and exit of vessels without any hitch or delay. These graving docks will be equal to the requirements of vessels of great size, and if the dividing caissons within were floated out, the Great Eastern could be berthed there. The main dock, from which extend three branches, has a water area of 53 acres. The wharves which jut out between the branches will be covered with warehouses, and branch lines from the adjacent railway will run along each wharf, and extend through every warehouse. This main dock has a length of 1600ft., with a width of 600ft., and a water area of 23 acres with a depth of 38ft. from Trinity high-water mark. The branches are 1600ft. long. The centre one will be 300ft. wide, and those at the sides will have an average width of 250ft.

In July† a splendid line of quay walls was opened at Antwerp with Royal celebrations, and thus another important piece of work has been completed towards restoring Antwerp to its early dignity amongst the greatest European ports.

The subsidence of the tunnel of the Metropolitan Railway near King's-cross, to which we referred in our two last impressions, is one which draws marked attention to the great value of the modern method of constructing these tunnels either upon a concrete bed under the whole area of the tunnel, or with concrete struts of large section between the footings. Speaking of concrete reminds us of the ever-increasing use of Portland cement at home and abroad, and of the extent to which America is now providing and taking steps to provide herself with this article, at present chiefly imported from England. Although Portland cement is very much less costly than it was, there is yet much to be done in cheapening its production. Amongst the uses of cement concrete, it is notable that at present it is little used as a substitute for the old fashioned clay puddle wall in waterworks embankments, and that no satisfactory method has yet been arrived at of building breakwaters and piers in one mass. The leakage at the Eccup reservoir of the Leeds water supply has been increasing instead of decreasing. From the newer leakage the escaped water makes its way to the outer side of the puddle trench, and is traceable there between the rock and the earth above it. It is said that the engineers (Messrs. Filliter and Rofe) and the Water Committee recommend the purchase, at a cost of a little short of £500, of a boring machine, by means of which they propose to make numerous holes from the surface down to the rock at the spot where the presence of escaped

* The Engineer, 3rd April, 1885, p. 262.
† The Engineer, 31st July, 1885, p. 91.

water shows itself. Into these holes is to be poured a cement which will set rapidly in water, and thus create a barrier which would prevent further leakage. Should this method fail, it is rumoured that the only alternative will be that of drawing all the water from the reservoir and reconstructing the puddle trench some distance further back, so that it may enclose the faulty places.

Work, it is said, will soon be commenced on the Simplon tunnel, by which the existing line from Geneva to Martigni and Brieg will be carried through the mountain to Domo d'Ossola, and so on to Pallanza or Stresa, on the Lago Maggiore. As this tunnel will be commenced at a much lower level than any of the others, it will necessarily be longer, the rough estimate being 20 kilos., or 12½ miles, and the estimated cost somewhere about 100,000,000 francs. The difficulties of ventilating so long a tunnel, which were once thought insuperable, have been pretty well disposed of by the experiences of St. Gothard, which is lighted by lamps placed at intervals of 1500 yards; and, although the temperature is certainly somewhat high—about 75 deg. Fah.—the traveller feels no discomfort, while the freedom from smoke is greater than in the shorter tunnels. There are fifty-six of these short spiral tunnels, extending over an aggregate of 25 miles. Notice has, it is said, been given of application to the Canadian Parliament for authority to build a tunnel under the Strait of Northumberland from Cape Tormentine to Cape Traverse, to connect Prince Edward Island with the mainland. At present communication is only to be had, during about five months of the year, by means of ice boats between Capes Tormentine and Traverse. The engineering difficulties in the way of the scheme are not considered insurmountable.

Lately complaints have been frequent in Birmingham respecting the emission of smoke by the tramway engines, and this has helped to direct attention more strongly to the cable tramways about to be constructed in that town by the Central Tramways Company from the designs of Mr. Joseph Kincaid and Mr. E. Pritchard, the engineers for the company, which has acquired the whole of the tramway rights. The cable tramway system will probably make some progress after this line has been made, and the uncertainties removed which have resulted from the action of the Steep Grades and Highgate Tramway Companies. Engineers will probably adopt a system of construction not affected by any of the patents possessed by the Steep Grades Company.

Although the Canadian Pacific Railway was practically completed some time ago, the official opening will not take place until May next, when the Governor-General of the Dominion, several senators and members of the Government, and other prominent persons will assemble to take part in the ceremony. By that time the section from Kamloops to the terminus of the Pacific shores will be completed, and the whole line, from the Atlantic to the sister ocean, will be in full and general operation for all purposes. At the present time steps are being taken to extend the Dunmore and Lethbridge Railway, which is already connected with the Canadian Pacific Railway, to the heart of the cattle-ranche district in Montana, U.S.

Upon designs prepared by Mr. T. Barham Foster, C.E., a scheme is being matured for encircling Manchester, Salford, and adjoining places by a railway for passengers and goods, about fourteen miles in length. Such a system of communication is greatly needed in this busy district, and it is somewhat surprising that something of the kind has not been done before now. By means of the projected scheme about twenty well-peopled townships will be accommodated.

The Hull and Barnsley Railway and Dock, which have for several years taken a conspicuous place in this article, were opened in July* last. It is the most extensive piece of railway completed in England for many years, and of it and the dock and its machinery† we have from time to time given full particulars and engravings.

The Bills in Parliament do not this year open up much prospect of new work. There are fewer in number than for years, and many of these are for abandonments. We cannot conclude this part of our notice of the year past and coming without a passing reference to the Institution of Civil Engineers, by which English engineering is represented. The Institution continues to grow in numbers and riches. The members of all classes now number nearly 5000 in all parts of the world, and the income of the Institute is over £15,000 per year, exclusive of receipts from investments reaching nearly £54,000. We have recently reviewed the publications of the Institution, and will only here say that it is high time the representative society of English engineering was provided with a more commodious and suitable home.

The modified Patent Law, from which so much was expected, has hitherto failed to produce any remarkably good and novel machinery, and the course of events during 1885 affords not the smallest promise that 1886 will usher in any startling novelties fit to take the world by storm. We have, we regret to say, nothing to record concerning triumphs won by mechanical engineers during the past twelve months, and the future is not promising. We are not to suppose that inventors have gone to sleep. Are there not some 17,000 patents taken out every year? During the year just passed, 16,101 applications were made, but valuable and useful inventions are scarce, and the publications of the Patent-office do not supply any accurate indication of the progress of a country.

The experience acquired during the last twelve months with the compound locomotive on the London and North-Western Railway does not seem to be encouraging. Mr. Webb's engines have been sharply criticised, but he is himself silent. Possibly we shall ere long have a direct exposition of facts from him in the shape of a paper read before some of the technical societies. More interest centres on Mr. Webb's experiment than on that of any other maker of compound locomotives, because the experiment has been made on a larger scale. Probably before 1886 has passed away it will be known whether the compound engine is or is not to be the locomotive of the future. We

* The Engineer, 24th July, p. 73.
† The Engineer, 9th January, p. 32.

have so fully and recently set forth our reasons for thinking that it is *not*, as a passenger engine at least, that we shall say no more on the subject now.

It is an interesting fact that in France the Crampton locomotive still holds its own against modern competitors. The first Crampton engine was designed in 1843. In 1851 was produced the Great Liverpool, the most powerful narrow gauge engine probably ever made; certainly by far the most powerful narrow gauge engine up to the date of its construction. This engine had eight wheels, the trailing wheels, with their axle just behind the fire-box, were the drivers; they were 8ft. high. The outside cylinders, set mid length of the boiler, were 18in. diameter, 24in. stroke; the grate had an area of $21\frac{1}{2}$ square feet: the fire-box 154 square feet, and 300 tubes $2\frac{3}{16}$in. outside diameter—2136 square feet. The total heating surface was 2270 square feet, and the weight of the engine full 35 tons. The great length of the wheel-base of this engine, and the weakness of the road over which it ran, were fatal to its success. The engine was, in short, in advance of its time. In France smaller engines earned fame, and it is stated that the record of the Crampton engines which have been used for thirty-six years on the Chemin de fer du Nord beats that of any other type of engine on the line—a fact which cannot fail to be gratifying to one of the few veteran engineers left among us. Much of this success has been due no doubt to the large bearings and wearing surfaces he adopted, with a prescience as rare as it was valuable.

It appears to be beyond question that there is a considerable demand for high-speed steam engines properly so called. The demand indeed is in excess of supply, because although a considerable measure of success has been attained by some engineers, these very gentlemen prove by taking out fresh patents that they are not yet quite satisfied with what they have accomplished. Great things were expected from the high-speed engines exhibited at South Kensington last summer. It is impossible to resist the conclusion, however, that the exhibition in question did the reputation of this type of motor more harm than good. It is unnecessary to use names, but we may say that not a few of the engines employed in supplying power for the electric light manifested a want of perception on the part of their designers, of the true requirements of the high-speed engine, which was not creditable to them. It really appears that engineers still live who entirely ignore the existence of centrifugal force, momentum, and the difference in the coefficients of expansion of various metals. The designing of a good high-speed engine is a complex and difficult operation; and no greater mistake can be made than to imagine that because such engines are, as a rule, small, they may therefore be made by rule-of-thumb. Concerning stationary steam engines of large power little need be said. The engines of Messrs. Hicks, Hargreaves, and Co., Messrs. Galloway, Messrs. Adamson, and several other makers, as shown at the Inventions Exhibition, represent, we suppose, English practice of the best type. Some of the engines shown did not, we regret to say, compare favourably with those exhibited contemporaneously at Antwerp, which we have very fully illustrated and described in The Engineer. The result of careful inquiries which we have made goes to show that the Belgian engineers do not find it worth their while to build any but first-class engines, while English engineers do. Although the number of engines exhibited at Antwerp was far in excess of the number shown at South Kensington, it was very difficult to find anything at the former place which was bad. No such difficulty presented itself in the Inventions Exhibition. The explanation given is that English engineers cannot find a market for a first-class engine. This view, it is fair to add, certain makers with high reputations will by no means endorse. As a matter of fact, however, it does not appear that the cost of a really good engine need greatly exceed that of a bad one. Steel is cheap enough—so cheap, that its use as a constructive material instead of iron represents little or no extra expenditure. Cast iron is not too dear to permit it to be used in sufficient abundance. If a rod has to be turned, it will not cost more to make it of one diameter than of another a shade smaller or larger. The production of good work requires great honesty of purpose on the part of all concerned; good tools of the right sort, and knowledge of their use and importance, but these things do not mean a large outlay. We may cite, for example, M. Bollinckx's system of securing everything on shafts, from a fly-wheel to a small lever, by forcing it on, no keys being used. It seems more than probable that the cost incurred in turning a crank shaft and boring out a crank boss with sufficient accuracy to render a key unnecessary, need not be as great as the cost of boring and turning both to a loose fit, and then putting in keyways, and forging and fitting keys. "It is as easy to do a thing right as wrong," is a very good motto to hang up in an engineer's shop, and it is quite certain that if we are to maintain our hold of foreign markets against foreign competitors we must not rely on rubbish as our mainstay simply because it is cheap.

Probably the most important subject connected with mechanical engineering to which we can refer is steel. No advance whatever has been made during the last ten years towards the elimination of the treacherous characteristics of the metal, and there is no reason to anticipate that it will be better in 1886 than it was in 1885. Indeed, there is some cause to fear steel is not so good as it was. Steel made by the Bessemer process at all events does not seem to enjoy the reputation it once did. It would be interesting to know why Siemens steel has come to be regarded by boiler makers and engineers as better, in the sense that it is more trustworthy, than Bessemer steel; and it may yet be that the product of the converter will be mainly devoted to rails and tires and axles, while boiler plates will be produced only by the Siemens process. So far as can be known, the unexpected fracture of steel plates is due to the spreading of extremely fine initial cracks in a way very clearly set forth in our last impression, and this can only, we fear, be controlled effectually by giving the plate a fibrous structure. Iron has been much abused for its laminated fracture; but it is the lamination of iron that has enabled it to attain the high position which it long held. The effect of lamination may be made clear by supposing that a boiler, instead of being built up of single plates 1in. thick, was composed of four plates each $\frac{1}{4}$in. thick, put together much as the coils of a gun are. In the first case, if a crack was once developed in, say, the outside of the single plate, it would quickly spread inwards, and cause the destruction of the boiler; but the outer plate of a shell built up of four plates being cracked through, the strength of the boiler would only be decreased 25 per cent., and the crack could not spread through the remaining plates. It is for this reason that we look on the metal produced by the Corngreaves Company with considerable favour. It is made by putting a number of wrought iron rods into an ingot mould and pouring steel in. The rods become welded to the steel without losing their fibrous nature. When the ingot is rolled down this wrought iron partakes of the general reduction of section, and thus a plate or rod of very perfect mechanical texture is produced. It ought to be possible, however, to carry this system further, and to produce boiler plates in which iron shall be, so to speak, sandwiched, for the express purpose of stopping the spread of cracks. How these cracks are generated is a very important question. They may be due to the cellular structure of the ingot, the cells being, of course, due to occluded gases. Some of the cells may be quite too small for easy detection, even if an ingot were broken across, and yet develope into a dangerous crack. A very interesting paper, entitled "Théorie Cellulaire des Propriétés de l'Acier," by MM. Osmond and Werth, has just been published in Paris by M. Dunod, Quai des Augustins. This does not refer to the gas cells of which we have just been speaking, but to what we may term the microscopical structure of steel. We have not space to quote from this pamphlet at length, but we may state briefly that the theory of the authors, based on microscopical and other researches, is that when heated steel loses its carbon, owing to dissociation, as it cools slowly it re-combines with a portion of this carbon, but not all; that some carbon is left free until the steel is tempered, when that carbon before free is re-combined; and that a steel bar really consists of an agglomeration of grains of steel secured to each other by a cement. Speaking of the cooling of an ingot and tracing the structural changes down, the authors say, "Finally there remains in the fluid state a mixture, more or less complex, commonly dominated by carburet of iron, which solidifies in its turn in the joints of the 'globulites,' and unites them into a solid block—c'est le ciment." The steel may be regarded as in the condition of a number of kernels surrounded each by an envelope of cement, and the strength of the steel depends on that of the cement. It is impossible to do justice in a limited space to the working out and proof of this theory. According to it, the cement not being equally distributed through the material, there may be, so to speak, small centres of weakness in it. We quote the author without translation:—Mais, comme le ciment n'est jamais réparti d'une façon absolument uniforme, certain noyaux peuvent briser leur enveloppe plus mince sous une pression plus faibles, d'autres, qui n'ont pas de'enveloppe sur une ou plusieurs faces, se déforment plus facilement encores; de la ces déchirures parfois visibles à la surface des barreaux d'épreuve, et les bruits que l'on entend pendant l'essai; *chaque cellule a en réalité sa limit élastique*, et celle que l'on attribue à l'acier ne correspond qu'un maximum d'un phénomène plus ou moins irrégulier." The author further states that shocks and vibrations, by breaking up the cement by degrees, will gradually reduce a bar of steel to a sort of metallic sand. It will be seen at a glance how important a bearing this theory has, if true, on that which attributes the treacherous fracture of steel to minute initial cracks, as set forth by "L." in our last impression. If the elastic limit varies throughout a bar or plate, then if this limit be once exceeded anywhere over ever so small an area, we may at once have a crack localised for the time being. Nothing but stress is required to develope it. This theory, too, very satisfactorily explains what has been pointed out by Mr. Parker and others, namely, that the more work we put into a plate, that is to say the oftener it goes through the rolls, the more likely is it to be honest.

Reference has been made in our columns to the failure of certain ship plates and angles in the North. It is not quite as easy as is desirable to get at the whole truth in these cases. Our inquiries have resulted in the acquisition of information to the effect that such failures have been comparatively numerous, and that the treacherous plates and angles have been in all these recent cases made of basic steel. It will be seen, however, from the letter of our north-eastern correspondent, that such failures are not confined to basic steel. Messrs. Bolckow, Vaughan, and Co. have in consequence stated that they will make no more basic plates or angles; and Lloyd's Committee have resolved not to class any ship built of basic steel, and have withdrawn their inspectors from yards where basic steel is used. This line of action must, however, be regarded as only provisional. As soon as the character of basic steel is re-established, it will be accepted by Lloyd's as a material suitable for the construction of ships. For certain purposes it appears to be an excellent metal, but it requires special treatment. Lloyd's will permit boilers to be made of it, but only under certain stipulations. Its strength must not exceed about 24 tons on the square inch, and the scantlings must be augmented as compared with acid and Siemens steel standing 30 tons. In fact, it appears to resemble Low Moor or Bowling iron more than anything else. It is worth notice that Lloyd's will not pass any steel which stands more than 30 tons, and when plates exceed 1in. in thickness the standard is lowered. In all this, we find direct evidence that practical men find it necessary to employ steel with much caution, notwithstanding the admirable qualities which it displays. We understand that Mr. Parker, chief engineer surveyor at Lloyd's, is now conducting a valuable series of experiments with a view to solve the steel problem, and ascertain why plates break. To this end he has subjected steel plates of all kinds to the worst possible treatment—such as heating one corner while the rest is kept cool, making a hot fire on the centre of a plate while a hose played on the metal outside the heated circle, and so on—but up to the present he has not succeeded in a single instance in getting a plate to crack.

It cannot be said that any failure of a steel plate is a surprise, because the treacherous character of the material under certain conditions of treatment has long been known. A valuable report to Lloyd's Committee on the steel manufacturing and engineering works of France was prepared by Mr. Parker in 1883. This report is not as well known as it should be. Among other places visited was the Naval Dockyard at Toulon. There they had been long aware of the peculiarities of steel. "The French engineers," says Mr. Parker, "seem to have recognised to a greater extent than has been done in England the fact that steel requires to be treated with much more care than iron, in order to preserve the normal qualities of the material in a structure; and the plate and angle shops in Toulon Dockyard are fitted with special tools, mostly hydraulic, so that it may not be necessary to hammer or distress the material in any way. These tools are so designed, and the plant is so arranged, that all the work necessary in either plates or angles may be done while the material is at a uniform heat, and before the temperature falls below the acknowledged dangerous limit of dark red. The frames are all heated in gas furnaces on the Gorman system, and by means of ropes, hydraulic capstans, and return pulleys, the frames are turned or drawn to their required curvature in a few seconds of time without any sudden shock or jar; they are then bevelled with squeezers, and when completed retain a sufficient heat to anneal them. Again, all garboard strake plates and others involving strong curvatures or sharp changes of form, that in this country are generally bent or flanged by hammers, are at these works bent to form by hydraulic presses, while all shears and punches are also worked by hydraulic power, so that there is a complete absence of jar or jerk in the speed of the tool at the moment when its edge comes in contact with the work punched or sheared, which must necessarily punish the material to a less degree than punches, presses, or shears driven by mechanical gearing. Further, with a view to avoid all useless punishment to the material by punching out curves, circular and curved hydraulic shears are extensively used, and I also observed that for cutting frames, beams, &c., circular and hand saws are used as much as possible. In fact, wherever it is possible to replace hand tool labour, the work of which must be rough and costly, machine tool labour has been introduced, which is much more regular and uniform, and injures the material so little that scarcely any annealing is necessary, and a fractured or cracked plate or angle, such as was so common here a few years ago, is almost unknown at these works." Further on Mr. Parker says:—"In view of the valuable information and experience gained during my visit to the Toulon yard, where steel has been so largely employed for the last ten years, I cannot but feel it is a matter for regret that, upon the introduction of steel for shipbuilding and boiler-making into this country some four years ago, recourse should not have been had by the society's officers to the experience of the French Government officials in the matter. If a visit had then been paid to the dockyards in France, it would, I doubt not, have saved both the committee and executive a great amount of anxiety, inseparable from the society's officers having had to work out for themselves the problems connected with the subject which experience alone could satisfactorily solve."

For the time we shall say no more about steel, and turn our attention to marine engineering. In this, unfortunately, as in every other branch of mechanical engineering, there has been through the year that is passed stagnation, due to the collapse of the shipping trade. It may interest Mr. Chamberlain to know that not a few firms are now running their ships without insuring them. Freights are so low and so hard to get that the cost of insurance cannot be incurred, and the owners maintain that they may just as well lose the ships at sea as suffer them to rot out in harbour. No decided advance in marine engineering has taken place in any direction during the past year, and nothing is now heard of the great pressures such as 160 lb., 180 lb., and even 200 lb., talked about this time twelvemonth. It seems to be generally accepted as proved that nothing is gained by going beyond 150 lb. Some quadruple expansion engines have been tried. The results have not been encouraging. They are in no sense better than those obtained from triple expansion. It must not be forgotten that shipowners care nothing at all about horse-power. They estimate power in pounds of coal and knots run and cargo carried. The triple expansion engine has proved itself to be just so much more economical than the ordinary compound that its use covers the whole cost of insurance, and in certain cases gives a margin besides. This is a very considerable gain. We believe that at this moment there is not being built in Great Britain a single two-cylinder compound marine engine of any considerable dimensions. Such engines are being as rapidly and completely superseded by the triple engine as they superseded the low-pressure engine and jet condenser. If business in the shipping world would get a little better, plenty of work would be found for engineers in converting the existing double-cylinder engines into triple engines. One large vessel has already had such a conversion effected. The double crank shaft has been taken out and replaced by a triple crank, the bed-plate has been lengthened, and another frame carrying a new high-pressure cylinder has been added. The boilers, carrying about 80 lb., have been taken out and replaced by new boilers carrying 150 lb. So far, the conversion has been perfectly successful; but in this case the engine-room was long, and so there was plenty of room. In the majority of cases, however, engineers will find themselves face to face with very nice problems when they attempt reorganisation of the kind, and plenty of opportunity will be afforded for scheming; because it will never do to throw away the double expansion engines if they can be utilised.

In the mercantile marine no advance has been made in the adoption of forced draught. The excellent results obtained by Mr. Howden with one of Mr. Scrutton's ships do not appear to have been repeated in the case of further experiments with other vessels. Be this as it may, it is certain that no more vessels are being fitted on the Howden system at present. In the Navy, on the contrary, forced draught is becoming the rule instead of the exception. The method adopted is thus described by Mr. Sennett:—"The stokeholes are enclosed for the purpose of being put under air pressure by getting a horizontal ceiling about 10ft. or 12ft. above the floor plates, extending from the coal bunker bulkheads to the fronts of the boilers, and from this ceiling vertical screen plates are carried down between and at the ends of the boilers to meet the front boiler bearers. These screen plates are worked around the fronts of the boilers to enclose the smoke-boxes so as to keep the stokeholes cool, and are carried back sufficiently far at the sides of the boiler to clear the water gauges. It will thus be seen that the stokeholes proper are readily made into closed air-tight chambers of comparatively small dimensions." The first ships in the Navy to which this system was applied are the Satellite and the Conqueror. During a four hours' full-power trial the Satellite developed with natural draught 10·15 indicated horse-power per square foot of grate surface, with an air pressure in the stokehole of $1\frac{1}{4}$in. to 2in. of water the power rose to 16·9 indicated horse-power. In the Conqueror natural draught gave 8 indicated horse-power per square foot of grate, and forced draught 16·46. During the three hours' trial of the iron-clad Rodney, made last year, an air pressure of 2in. gave 17·3 indicated horse-power per foot of grate. It may be taken as proved, therefore, that an air pressure of 2in. of water in the stokehole will augment boiler efficiency by 70 per cent. It may be worth while to point out that this augmentation permits a great saving to be made in the weight of boilers and machinery. With forced draught, a horse-power indicated can be got from 2 cwt. of machinery.

The accompanying table shows in a compact form what has been done:—

sented the finest type of steam war ship of the day, the maximum indicated horse-power was less than 2000, and the speed about 10 knots. In the despatch vessel Iris, two sets of engines are fitted together, capable of developing 7700 indicated horse-power, and of driving the ship at a speed of $18\frac{1}{2}$ knots an hour. In the twin-screw armoured ship Rodney, of 10,000 tons displacement, the average indicated horse-power developed during a four hours' full power trial under forced draught, made June 13th, 1885, was 11,200, and in the armour-clad ships, Renown and Sanspareil, now building, the guaranteed minimum indicated horse-power is 12,000.

As something has been recently heard about a vessel fitted with petroleum furnaces, tried on the Thames, we may say that she is a vessel of about 900 tons, and that the experiments made with her so far have not given satisfactory results. During a trip from London to the North it was found impossible to keep up the boiler pressure sufficiently for a speed of more than about 7 knots. The quantity of steam used for blowing the petroleum into the furnace is considerable, and the supplementary feed had to be so freely used that the water became very salt in the boiler before the end of the voyage. Improvements are to be effected, when we may hear something more about the scheme. It is not easy to see how the use of petroleum in any form can be made a complete success in this country, whatever it may be in the Caspian Sea, and the dangerously inflammable nature of the fuel must not be forgotten.

Our glance at mechanical engineering would be incomplete without a reference to boilers. There is a feeling growing up that considerable changes ought to be made in the present system of boiler construction. Boilers may be divided into three great classes—stationary land boilers, locomotive land boilers, and marine boilers. The last may be made to include a class growing in importance, namely, locomotive marine boilers. Until very recently indeed the prevailing type of land stationary boiler was the Lancashire, or as we have heard it called, the double-flued Cornish. It is not very easy to see why it has so long enjoyed favour. It is very expensive, not only to buy, but to transport from place to place. It requires very costly brick-

Name of vessel.	I.H.P.		Grate surface.		Time of trial.		I.H.P. per sq. ft. grate.		Coal per I.H.P.		Per c'nt. of gain of I.H.P. per sq. ft. of grate.	Method of forcing the draught.
	Natural dra'ght.	Forced dra'ght.	Natural dra'ght.	Forced dra'ght.	Natural dra'ght.	Forced dra'ght.	Natural dra'ght.	Forced dra'ght.	Natural dra'ght.	Forced dra'ght.		
French Navy—												
Foudroyant	6016	8088	732	732	—	—	8·22	11·05	2·20	2·51	34·4	Jet in chimney.
Duperré..	6075	8010	730	730	—	—	8·33	10·99	2·20	2·42	31·9	,, ,,
Bayard	3255	4064	416	416	—	—	7·82	9·67	2·31	2·73	24·8	,, ,,
Naiade	2663	3215	340	340	—	—	7·83	9·46	2·42	2·98	20·7	,, ,,
Iphigenie	2230	2762	284	284	—	—	7·85	9·73	2·09	2·09	23·9	,, ,,
Sfax (est.)	5000	7500	538	538	—	—	9·29	14·00	—	—	50·	Closed fire-room.
English ironclads—												
Collingwood..	8360	9558	—	—	—	—	—	—	—	—	—	,, ,,
Rodney	8262	11156	—	—	—	—	—	—	—	—	35·03	,, ,,
Renown (est.)	5500	8500	570	—	—	—	9·65	15·00	—	—	54·5	,, ,,
Benbow (est.)	7500	9800	—	—	Hours.	Hours.	—	—	—	—	30·7	,, ,,
Conqueror	4658	4023	574	293	2	$1\frac{1}{2}$	7·96	13·41	—	—	68·5	,, ,,
English cruisers—												
Leander..	4233	4658	545	545	—	—	7·77	8·55	2·01	1·98	10·04	Jets wide open.
Heroine..	1127	702	110	55	6	3	10·25	12·8	—	—	24·9	,, ,,
Hyacinth	1195	1445	110	110	3	2	10·87	13·13	—	—	20·9	,, ,,
Satellite..	1116	1397	110	82·5	4	2	10·15	16·9	—	—	66·5	Closed fire-room.
English Des. Boats—												
Alacrity..	2157	3173	—	—	6	6	—	—	2·1	2·77	47·0	,, ,,
Surprise	2104	3017	—	—	6	6	—	—	2·6	2·78	43·4	,, ,,
Archer class (est.) ..	2400	3500	224	224	—	—	10·7	15·6	—	—	45·2	,, ,,
Scout class (est.).. ..	2100	3200	204	204	—	—	10·2	15·6	—	—	52·4	,, ,,
Curlew class (est.) ..	850	1200	—	—	—	—	—	—	—	—	41·2	,, ,,
Mean of three vessels.	1875	2800	—	—	—	—	—	—	—	—	33·0	,, ,,
German Navy—												
Blitz	1794	2808	298·5	298·5	—	6	6·01	9·43	—	—	56·4	,, ,,
Brazilian Navy—			Boilers.	Boilers.								
Riachuelo	6926	7336	10	8	—	—	—	—	—	—	27·0	,, ,,
Aquidabam	5270	6201	—	—	—	—	—	—	—	—	—	,, ,,
U.S. Navy—												
Dolphin..	1648	2253	270	270	6	6	6·1	8·35	—	—	36·7	Open fire-room and blowers.

According to the United States *Mechanical Engineer*, the system now used was invented many years ago at the other side of the Atlantic. "In the Stevens Battery," says our contemporary, "designed and built in Hoboken, the plan introduced was a forced draft secured by making the fire-room air-tight, and forcing in the air required to support combustion by means of blowers, a method that has been proven on large naval steamers, and can be relied on as much more effective and convenient, and far more comfortable than the old plan of leading the air directly to the ash-pits. This plan was introduced by the late Robert L. Stevens many years ago, as in 1847 the Robert L. Stevens had an air-tight fire-room. The engines of this vessel were built at the Morgan Works, and the boilers, &c., at Hoboken. The success of this experiment led to its application on the Northern Indiana and Southern Michigan, passenger steamers on Lake Erie, in 1850. This became the common lake practice, but on the New York, Long Island Sound, and Hudson River steamers, the air-blast under the grates was generally used." Experiments are now being made at the Brooklyn Navy-yard on forced combustion, the coal, anthracite, being burned at the rate of about 19 lb. per square foot of grate per hour with natural draft, and 38·5 with a screw revolving in the chimney. The consumption of coal was doubled, and the production of steam augmented 80 per cent.

The following quotation from Mr. Sennett's book before referred to,* will show the progress that has been made during the last half century; and this progress is all due to practical men; the man of pure science has in no way contributed to it:—"The machinery of the Rhadamanthus, built in 1832, weighed 275 tons, and developed 400 indicated horse-power. In modern war ships, machinery of the same weight would, under forced draught, be capable of developing at least 3000 indicated horse-power, and the space occupied would be considerably less. Between 1850 and 1860 naval marine engines weighed about $3\frac{3}{4}$ cwt. per indicated horse-power. Another important feature is the great increase in total power now available for the propulsion of vessels. For example, in H.M.S. Terrible, which in 1845 repre-

* "The Marine Steam Engine," by Richard Sennett, R.N. Second edition.

work setting; it is not economical; it is not a good smoke preventer; it requires constant inspection to prevent dangerous corrosion taking place in the shell. The collapse of the flues is a common occurrence, and we hear now and then of disastrous explosions from this cause. It is not remarkable that the locomotive type of boiler is slowly superseding it here; and it never enjoyed favour out of Great Britain. The water-tube boiler has, we have no doubt, a great future before it. It is a remarkable fact, however, that in this country this type of boiler cannot be made to give the satisfactory results obtained with it abroad. The chances are that no really good water-tube boiler has ever been properly pushed in this country. The success of such makers as Babcock and Wilcox in America, De Naeyer in Belgium, and, to a limited extent, Root in this country, are all evidences that the time may not be far distant when a perfectly safe and eminently economical generator may take the place of one which has really very little but its antiquity to recommend it.

So far as present appearances are concerned, the subject of the London water supply does not appear likely to be particularly prominent in Parliament during the coming session. The Metropolitan Board is going to introduce a Bill which may be considered identical with one brought forward previously, except that it does not propose the expenditure of money to promote private litigation against the water companies. The main feature of the measure is to obtain such power as will enable the Board to submit a scheme to Parliament dealing with the entire question of the London water supply, that is to say, either to buy up the companies, or a fractional part, or to introduce a supply of water from a fresh source. In addition, it is sought that the Board shall have power to incur any necessary expenditure in opposing Bills relating to the supply of water in or near the metropolis. As the water authority for the metropolis, the Board has already been active in this direction, having opposed several water Bills in Parliament. Whether the opposition has always been wise may be open to doubt. A parliamentary return has lately appeared, showing the financial results accruing from the rejection of the Metropolis Waterworks Purchase Bill of 1880. Mr. Allen Stoneham, the Government auditor appointed under the Metropolis Water Act of 1871, states that the excess of earnings by the companies over and above the interest that would have accrued to them under the Purchase Bill, amounted to very nearly £100,000 by the close of 1884, in addition to which the ratepayers would have realised the benefit of cash balances in the hands of the companies at the time of the proposed transfer, amounting to about £300,000. On the other side of the account is the expenditure by the companies of more than £900,000 in extension of their works—an outlay which is presumed to have been necessary in order to maintain their income. An important public saving would have been effected by the consolidation of the undertakings under one management, and the working expenses would have been materially reduced. Mr. Edward J. Watherston, taking up this theme in a letter to the *Times*, calculates that if the Purchase Bill had been passed, embodying the provisional agreements negotiated by Mr. Edmund J. Smith, the money advantage accruing to the London ratepayers at the close of 1893 would have been no less than £2,376,357. "Time has flown," says Mr. Watherston, looking back to the period 1879-80, "and now every word said by Mr. E. J. Smith is proved to have been correct." But the recent parliamentary return, which furnishes the requisite data, has received very little notice. Had the figures been such as to warrant a conclusion adverse to the Purchase Bill, there is no doubt public attention would have been powerfully drawn to the subject. That the return will influence general opinion in favour of the companies is not exactly what may be expected. It may, perhaps, rather exasperate than conciliate, the inference being that the companies have been squeezing the consumers in order to raise the revenue. But as the companies have to keep within the four corners of the several Acts by which they are established, and are also subject to the provisions of the Metropolis Water Act, it is hardly possible for them to obtain more than their due, except in a very small measure. The local authorities are taking their revenge upon them by enormously increasing their assessments, so as to make the companies large contributors to the local rates. The burden thus imposed has become seriously heavy. In Parliament the companies find little favour, of which an example occurs in the passing of the Water Rate Definition Act, by which at one blow the basis of the water rate has been lowered from the annual value, as apparently settled by the famous Dobbs decision, to the standard of the rateable value, as settled by the parish authorities. As the Assessment Committees are practically identified with the Boards of Guardians, there is no disposition to make the rateable value less than can be helped. So far the interests of the water companies are indirectly favoured, and as the new Act enables the companies to raise their charges in accordance with each fresh valuation, they will receive some benefit in the course of time, unless Parliament should interpose to prevent this upward tendency. An arrest of this kind has already been proposed, and it is very possible that some further attempt of that nature will be made. Another proceeding on the part of the Legislature has borne with especial weight on one particular company, namely, the Southwark and Vauxhall, whose Bill of last session was rejected in the Commons after it had passed the Lords. An expenditure of £3000 was thus irretrievably lost, and had to be paid out of revenue, to the detriment of the dividend. The powers sought by the Bill are so indispensable to the fulfilment of the duties and responsibilities devolving on the company that it will have to be reintroduced this year, and the matter is declared to be urgent, having in view the continual increase of the population. The East London Company and the Lambeth have also each given notice of a Bill for the coming session. None of the provincial water schemes for this year are of any special magnitude. Perhaps one of the most important matters affecting the water supply, not only of London, but of the country at large, is that which relates to certain marked improvements in analysis. Great progress is being made in the detection of organic life in potable water. One method is that known as the gelatine process, associated more or less with the name of Dr. Koch, and now made the basis of a monthly report by Dr. Percy Frankland in respect to the metropolitan supply. Another method, possessing peculiar merits, has been devised by Dr. Dupré, and is dependent on the absorption of oxygen by the water under examination. Great expectations are entertained concerning it, and it may be designated the most severe test hitherto applied for detecting the presence of living organisms in potable water. We cannot help noticing with great satisfaction that the alarming decision of Mr. Justice Pearson, in the case of Ballard *v.* Tomlinson, whereby it was declared that underground water might be polluted with impunity, was subsequently reversed by the Lords Justices in the Supreme Court of Judicature, on an appeal from the plaintiff.

Cheap gas is now the order of the day, coupled with better appliances for burning it, whether with respect to lighting or heating. Of these devices there was a large display in the International Inventions Exhibition of last year, but considerable dissatisfaction has been expressed at the awards made by the jurors. By subsequently altering some of their awards the jurors have shown a desire to do right, but have also given force to unfavourable criticisms on their judgment. A matter of importance as affecting the contract between producers and consumers consists in the unsettled state of the standard of light. The sperm candle is the statutory appliance for the measurement of artificial light, yet it may be described as almost universally condemned. The need of something more trustworthy is widely felt, but opinions differ as to what should be the substitute. Mr. Dibdin, the chemist to the Metropolitan Board, has conducted a valuable series of experiments on the subject, and what may be considered a final investigation is now in hand. Different conclusions may be drawn from the same data, but there can be no doubt that these researches will materially assist in the settlement of this long-pending dispute. In respect to the price of gas, the most notable event is the reduction just now coming into force in South London, the South Metropolitan Company having lowered its charge to half-a-crown per 1000ft. This necessitates a reduction to the same price in that part of the Chartered district which lies south of the Thames. The Chartered Company will also have to reduce its charge for public lighting throughout its immense area, both north and south of the Thames, so as to bring its price for this description of lighting into conformity with the South Metropolitan scale. The latter company is now constructing immense works in the Greenwich marshes by the riverside, and will doubtless have to meet a large demand. An amalgamation between the South Metropolitan Company and the two companies supplying Woolwich took effect at the commencement of last year. Two noted lawsuits connected with gas matters deserve mention. In May last judgment was given in the case of Sugg *v.* Bray, but it cannot be said that the results have any particular value for the public. Judgment in the gas engine case, Otto *v.* Steel, was given only a few days ago, and possessed considerable interest, involving a complete victory for the plaintiff.

The sewage question attracts attention at the present time more especially with respect to the state of the Thames both above and below the metropolis. Towards the close of 1884, the second report of the Royal Commission on Metropolitan Sewage Discharge made its appearance, giving a very serious aspect to the future of the main drainage outfalls. Thus far the proposals of the Royal Commissioners may be said to remain in abeyance, or at least are only partially recognised, the Metropolitan Board seeking the end in view by methods somewhat different from those proposed by Lord Bramwell and his colleagues. The Commissioners demanded that no raw sewage should enter the Thames. To that extent the Metropolitan Board is in agreement with the Commissioners, and operations are on foot which are intended to culminate in such purification of the sewage by chemical means as shall render it innocuous when cast into the river. But as the contemplated points of discharge are at the old outfalls, at Barking and Crossness, one demand of the Royal Commissioners is being set aside. This demand was that, if the effluent were to enter the Thames near London, chemical treatment alone should not be relied upon, but should be supplemented by land filtration. The plan devised by Sir J. Bazalgette and Mr. W. J. Dibdin is that of chemically purifying the sewage at the existing outfalls, and passing the effluent straight into the river. In summer, so long as the weather is hot, the effluent is to be subjected to special chemical treatment, so as to prevent all risk of annoyance. The plan of discharging the effluent direct into the stream is that which the Royal Commissioners would not approve, unless the discharge took place at least as far down the river as Hole Haven. A plan prepared by Sir J. Bazalgette proposed a system of drainage which would not only take in the sewage of London, but also that of the Lower Thames Valley and the valley of the Lea, the outfall being at Thames Haven. This was not carrying the sewage quite far enough down the stream, and the neighbourhood of Canvey Island was mentioned as preferable. Otherwise the project was favourably received by the Commissioners, and it would evidently have pleased them well could the plan have been adopted of combining all the sewage and taking it down to the mouth of the Thames, there to be precipitated, and the effluent sent into the estuary. The disposal of the sludge is in either case a matter of some difficulty, particularly on the extensive scale incidental to the immense volume of London sewage. In his plans for the treatment of the metropolitan sewage alone, Sir J. Bazalgette assumes a prospective population of 5,200,000, and a volume equal to 162,500,000 gallons per day. Very probably Sir J. Bazalgette would prefer constructing a great sewer to carry off everything down to Hole Haven, or thereabouts. The chemical plan is obviously due to the ingenuity and enterprise of Mr. Dibdin, aided, of course, by the engineering skill of Sir Joseph. The latter has seen what can be done on a chemical plan with London sewage in the course of a considerable series of experiments commencing at the Western Pumping Station at Pimlico as far back as March, 1884. These operations were afterwards transferred to Crossness, and have now attained considerable magnitude, the work being advanced by stages, so as to prove at each step what would be the best mode of attacking the entire problem. There is no doubt that by this time the Board is satisfied with the chemical plans, and possesses confidence that the result will be such as to meet every reasonable requirement. That a good effluent can be turned out at a much more moderate cost than the £200,000 per annum estimated by the Royal Commissioners, is considered an assured fact. Half that sum will suffice; and to this yearly expenditure will be added the interest and depreciation connected with a capital account of £1,140,000. The disposal of the sludge is included in this estimate, but the exact mode of getting rid of this refuse commodity is not yet precisely determined. Mr. J. Orwell Phillips, the secretary and manager of the Gas Light and Coke Company, has proposed to take the sludge, when compressed into cakes, and carry it off to the German Ocean in the Beckton steam colliers on their return voyage to the Tyne. A letter from Mr. Phillips, going very carefully into the details of this proposal, has lately appeared in our columns; but the Metropolitan Board has looked upon the project as too costly, and is trying to see whether it can carry out a similar scheme in a cheaper way. Contemporaneously with Mr. Phillips, we find Lieutenant-Colonel Jones and Mr. J. Bailey Denton pressing their project for carrying the sewage down to Canvey Island. To accomplish this plan, a moderate prolongation of Sir J. Bazalgette's proposed sewer would be required. The projectors urge that, taken at its best, the treatment of the sewage at the present outfalls by chemical precipitation, and the removal of the sludge to the sea, can only be a partial and temporary measure, and that in respect to cost, their own plan would be found at least 50 per cent. cheaper than that which the Board apparently intend to adopt. They ask that their plans should be submitted to the independent examination of a competent authority, and that the forthcoming expenditure at the outfalls should be deferred until the truth of their allegations has been either proved or disproved. But the Metropolitan Board displays no intention to alter its course, and we may presume, though with some admixture of doubt, that a trial of its plans will be permitted. There is a peculiarity in the case, that the effluent passes into a portion of the river utterly unconnected with the supply of drinking water. Hence a lesser degree of purity is necessary than in most cases where a river is concerned. Had the Metropolitan Board at the first adopted a process of clarification and deodorisation, such as was evidently contemplated by Parliament, all the disturbance about sewage banks and the pollution of the stream might have been avoided, and a smaller outlay required than that with which the ratepayers are now threatened. While the Thames is thus under consideration, the state of the tributary Lea is sufficiently serious, giving rise to an extraordinary popular demonstration during the summer heats. Notice has been given of a Bill to effect the purification of the Lea, by compelling the Tottenham Local Board to disinfect and purify the sewage passing into its works, and excluding the effluent from the river. The Bill provides that the effluent shall be diverted into the sewers of the Hackney Local Board and the Metropolitan Board of Works. Sir J. Bazalgette objects that the outfall works, as at present existing, cannot be made to deal satisfactorily with any more sewage than that of the metropolis. In fact they require enlargement, and this would have been taken in hand some time ago, but for the appointment of the late Royal Commission. In respect to the Thames above London, the past year has witnessed the breaking up of the Lower Thames Valley Main Sewerage Board, and the separation of the district into minor jurisdictions. The Kingston Corporation have just sealed an agreement for the treatment of their sewage by the Native Guano Company. A main drainage scheme for Richmond, devised by Mr. Melliss, has been provisionally adopted by the Select Vestry of that town. According to this project, works of precipitation and filtration are to be established at Mortlake, and the total cost ranges from £71,000 to £97,000, according to the extent of the district embraced. The Chiswick Local Board threaten determined opposition.

LETTERS TO THE EDITOR.

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

THE PECULIARITIES OF STEEL.

SIR,—Mr. Maginnis's story, entitled "A Strange Failure of Steel Boilers," which appeared in THE ENGINEER of December 11th, has certainly set the iron and steel world in a twitter of excitement. Mr. Maginnis deserves the gratitude of the whole profession for the clearness and straightforwardness of his narrative, which carries with it the conviction that it is the truth, the whole truth, and nothing but the truth. What ought now to be done is, by extended and unreserved discussion, and by the collection of further evidence, to endeavour to mature technical opinion under these new and perplexing circumstances. Valuable contributions have already appeared in the columns of THE ENGINEER tending to this end, but much more remains to be said. Several of these contributions had for their object to show that the steel in question was not Bessemer basic steel, as none made by that process had been manufactured into plates when these boilers were made. The manager of the Weardale Coal and Iron Company has now come forward and candidly admitted that the steel was made at the works of his company by the Bessemer acid process five years ago, thus relieving the basic steelmakers of the responsibility incorrectly assigned to them in the first instance. Whilst Mr. Du Pre deserves thanks for his frank admission, he can scarcely be congratulated on the vein of inconsistency which permeates his letter. The inconsistency is found in the diametrically opposite tendency of the first and last portions thereof.

The first portion is to the effect that the steel was good; that it was proved so by the tests made before leaving, by Lloyd's, and by Board of Trade surveyors; that it was the same as has been supplied for years for numerous boilers, without any serious complaint; that he cannot account for the failure, and suggests it must have arisen from peculiar treatment by the boiler maker or by the sea-going engineers.

If the above means anything at all, it means that Mr. Du Pre defends the quality of the Bessemer acid steel plates hitherto made by his company, through thick and thin, and against all comers; and if those plates have ever failed in use, he declares it is some one else's fault, and not theirs. In the latter portion of his letter, Mr. Du Pre carefully informs the public that for the last eighteen months the Siemens has displaced entirely the Bessemer process at the very same works; that the plant connected with the latter is now inoperative, and in his opinion it will never be restarted! Now this, if it means anything, means that in the opinion of the Weardale Coal and Iron Company the Siemens process is superior to its competitor for making steel plates, and it would be interesting to know why.

Why should Mr. Du Pre take such pains to extol Bessemer plates in one breath, and be so careful in the next to proclaim that he is never going to make any more? Mr. Maginnis' story dashes to the ground most completely the old hypothesis whereby engineers are accustomed to interpret any failure of steel boilers. For instance, though the holes in the curved plates were drilled, it is stated that those in the flat plates were punched. Some have said this would account for the commencement of the cracks. A careful perusal, however, of the drawings and description reveals the curious fact that three-fourths of the cracks have avoided rivet-holes and stay-holes altogether. In fact, they have apparently been quite indifferent to their proximity. In many cases where passing through rivet-holes would have shortened the route, the cracks have actually gone somewhat round about and avoided them. Most of the ruptures affect plates which must have been heated during construction for bending, welding, or flanging. The question naturally arises whether such plates were annealed before being put in place. Mr. Maginnis, however, tells us most distinctly that they were all annealed. Again, the hypothesis that only plates some time subjected to smithwork were at fault, is demolished by the circumstance that one of the top shell-plates flew like the rest on slight provocation, when the bottom flange of one of the neckpieces was being wedged from it.

It is a remarkable circumstance, and one of which too little notice has as yet been taken, that almost all the cracks took place when the boilers were out of use, and the metal quite cold. Only in one case did the engineers find out by means of a leak that a defect had occurred while they were at work. It is probable that in this one case it had originated at the same time as the others, but had not then been detected. In the other cases the cracks indicated the moment of their commencement by a sharp report, or by coming into view when the boilers were being sealed or hammered, and under the very eyes of the engineers.

It may be taken for granted that the period of maximum internal stress in the plates of a steel boiler is when it is empty and cold, and some time after it has been in use. It is almost certain that in proportion to the amount and intensity of furnace heat they are subjected to, under ordinary work, so will be their internal deterioration and proximate liability to fracture. But the similar cracking of the neck pieces, and especially of the shell-plate at the top of the boiler, would seem to indicate that the mere heat of the steam is sufficient to produce deterioration after a time. This deterioration of homogeneous substances through repeated alternations of temperature is nothing new. But it has not often been pointed out that final rupture occurs usually some time after the cause of deterioration has ceased to operate.

The writer of the article in THE ENGINEER of the 25th December, who signs himself "L.," has pointed out very clearly and correctly the strong resemblance there is between the behaviour of mild steel and that of glass under the influence of alternations of temperature. Glass is, in its way, as wonderful a material as mild steel. Consider, for instance, how easily it can be drawn out into silk-like threads, bent, cast, blown, moulded, drilled, ground, cut, polished, and otherwise manipulated, notwithstanding its proverbial brittleness. Consider its behaviour in the form of a cylindrical chimney for an Argand gas burner. The wonder is that it stands at all when so close to an exceedingly hot flame. It does, however, and often for a considerable length of time. The writer's experience is that these glass chimneys do gradually deteriorate and eventually crack of themselves from the internal stresses set up by a series of heat alternations. Quite lately two instances have occurred wherein they have suddenly flown to pieces without warning or obvious cause when quite cold, and hours after the gas had been turned off. Rupert's drops and toughened glass articles, which fly to pieces on being merely scratched, are instances, perhaps exaggerated ones, of the same thing. It seems, at any rate, probable that steel in the form of plates and angles, of however good quality originally and by what severer process made, are liable to deterioration from alternations of heat just as glass is.

Mr. Maginnis has not told us distinctly if he discovered any sign of contraction at the edges of the numerous cracks he has delineated and described. The fact that some of them occurred suddenly with a sharp report, and others began with fine thread-like severances, afterwards widening out, would seem to indicate that, as usual, there was no contraction. If so, Mr. Wicksteed's eloquent plea for his beautiful testing apparatus is scarcely convincing. Every test piece, whether tested before the boilers were made or after they had failed, contracted in the testing machine very considerably—never less than 15 per cent. of the original area. What can be said to warrant fractures developing in various directions and numerous plates without any contraction at all? The steam-user, the boilermaker, and the inspecting engineer, when they see the "autobiographies" of the test pieces of a boiler referred to by Mr. Wicksteed, naturally say: "Well, at all events, no rupture of this boiler can take place unless it first swells to 15 per cent. beyond its original dimensions." We now know to our sorrow that such hopes are entirely delusive, and that steel, when it cracks in use, cracks without warning, without contraction, and without extension.

Mr. Harrison's preference for small instead of monster plates in boilers is well worthy of consideration. The tendency of late among steel makers has been entirely in the direction of larger and heavier mills to make larger and heavier plates. At the last meeting of the Iron and Steel Institute prominent steel makers were advocating sizes hitherto unheard of. Every steel works recently put down has been designed with this object in view; and, indeed, a kind of mania for big sizes, and big machinery to make them, appears to have set in. Mr. Harrison thinks large plates in boilers are wrong, and very possibly Mr. Harrison, with his thirty-seven years of experience, is right. The internal strains tending to tear to pieces large steel plates must of necessity be greater and more dangerous than those in smaller ones. A cast iron floor plate 3ft. or 4ft. square will stand well enough; but a similar plate 9ft. or 10ft. square will, even if cast successfully, not be long before it splits in two of its own accord. It appears that in America the inside fire-boxes of locomotives are made of steel and last fairly well. At Crewe an experiment in the same direction was made and abandoned, because the steel plates cracked. But the Americans use small plates rivetted together, instead of the larger ones used at Crewe to avoid rivetting.

December 28th. IRON.

SIR,—Your remarks in reference to the steel which "flew off like so much glass" recalls that a few years ago the half suppressed reports on the bursting of the guns on board the Thunderer and Duilio compelled many to think, "for all my mind is clouded with a doubt," that there are more things in heaven and earth than are dreamed of in the philosophy of Woolwich and Elswick, and has confirmed my primitive crude ideas on the brittleness of cold chilled steel distempered by the hydraulic pressure on cold water in the sponging of the large guns. There is always a limit to the tenacity and soundness of any large mass of metal. Concussion and vibration will change the grain of metal from fibrous to crystalline in guns, boilers, and steamers. Brittle glass can be made strong and tough by annealing. Any iron and steel exposed in cold frosty weather, either by night or by day, but especially in the long winter nights, become like glass, brittle, and requires annealing or re-tempering to soften it. Good iron annealed, case-hardened, or re-tempered by Professor Barff's process of black magnetic oxide of iron, has been made like tough soft steel, and has actually in my own experience turned the edges of the best steel files, and even cold chisels, and when at last by patience and hard hammering it was penetrated, the iron cut clean, exactly like good steel. This is a stubborn fact that admits of many practical inductions suggestive of doubts and a want of confidence in cold steel unless properly handled, and either the gradually accumulator progressive or even instantaneous crystallisation of chilled steel. This is a very seriously important matter of consideration as to how many more sternposts or propeller shafts shall drop off suddenly and unaccountably without any previous warning. *Experientia docet.* Trusting you will not let this subject be left here, but on the contrary invite a full entirely complete prevention, which is always better than a cure for such an internal and external complaint in steel tubes of whatever kind. GEORGE FAWCUS.

Genoa, December 24th.

SIR,—Mr. Du Pre's letter is satisfactory as far as it goes, because it takes the blame off shoulders which have quite enough to carry as it is. But in such a case, not only is the truth wanted, but the whole truth; and this, Mr. F. B. Du Pre has, I submit, not told yet.

If I am wrong in what follows he will correct me. I advance nothing save for the sake of truth. The Weardale Company enjoyed a high reputation for their steel plates. All the company's plant was light. In an evil hour they undertook to make heavy plates, with the result stated by Mr. Maginnis. These plates were made from ingots not more than 8in. or 9in. thick. There was not a hammer or a cogger in the place fit to deal with anything bigger. In consequence the steel never was worked as it ought to be. Messrs. Jack, of Liverpool, made the boilers, and over 40 per cent. of all the plates supplied failed to pass the tests, and were returned to the makers. The wonder is, not that the boilers gave way, but that they held out for two and a-half years.

To assert that such stuff represents steel is nonsense. Putting it in the market at all is a wrong to other steel makers. The Weardale Company *now* make as good a steel as there is in the market. BASIC.

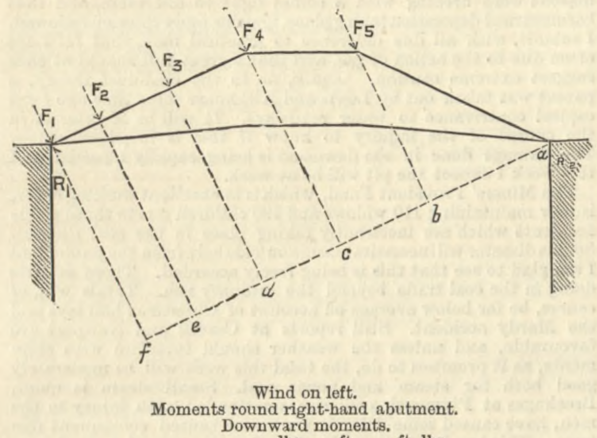
December 30th.

SIR,—The late Sir William Siemens, when discussing the question of "mysterious cracks" in steel, used to compare its behaviour under a tearing action with that of india-rubber. Your correspondent "L." compares it with glass. Our choice is wide enough, and I suggest that we narrow the limits and compare it with rolled copper having, say, the same percentage of elongation as a steel boiler plate, and a tensile strength and modulus of elasticity one-half as great. There is "no appreciable interposition of cinder or other foreign substance" in either case, and if homogeneity is the cause of "mysterious cracks," perhaps supporters of that theory will give us some examples of their occurrence in copper plates, sheet lead, and similar materials. B.

December 28th.

HUDDERSFIELD STATION ROOF.

SIR,—Mr. R. E. Ellis' diagram in your last number does not conform to the first principle of the polygon of forces, viz., that the lines of the diagram should be parallel to the members of the frame which they represent; compare, for instance, B_3 on the roof diagram with B_3 on the strain diagram. No doubt he has suffered at the printer's hands as much as I; but however accurately he were to draw his diagram, he would not obtain the figure he gives without distorting his brace-strains somewhat in the way he has done. The reason of this is that both in his diagram and in the one given in my letter the reactions are not quite accurate. In regard to mine, I endeavoured to correct the proof, as you are aware, in your office; but finding that the letter would have to stand over another week, with some reluctance I let it go as it was. For this reason I explained, first of all, that it was made by one of the students attending my class at Exeter Hall—I may add, after only hearing eight lectures. Secondly, that it should only be taken to indicate the maximum strain upon the counterbrace, the error for that piece being on the side of safety. We found in class that it was best to obtain the reactions on the abutments by means of moments about the opposite abutment thus:—



Wind on left.
Moments round right-hand abutment.
Downward moments.

	lbs.		ft.		ft. lbs.
$F_1 \times af$ =	1254	×	70·2	=	88030·8
+ $F_2 \times ae$ =	2867	×	61·1	=	175173·7
+ $F_3 \times ad$ =	3046	×	50·8	=	154736·8
+ $F_4 \times ac$ =	3501	×	37·4	=	130937·4
+ $F_5 \times ab$ =	1092	×	20·75	=	22659·0

Total downward moment 571537·7

Upward moment.

$= R_1 \times af = R_1 \times 70{\cdot}2 = 571537{\cdot}7$

whence $R_1 = \frac{571537{\cdot}7}{70{\cdot}2} = 8141{\cdot}6$ lbs.

and $R_2 =$ 3618 4

11760·0

By this means a perfect diagram was obtained without any distortion to a scale ten times the size of that given in your columns—that is, 1000 lb. per inch. In the diagrams given by Mr. Ellis the reactions are $R_1 = 7600$; $R_2 = 4000$. T. G. GRIBBLE.

Spring-gardens, Dec. 21st.

OTTO *v.* STEEL.

SIR,—Perusal of your report of the judgment in this action was somewhat startling as to the sudden demise of Otto's cushion. After being discussed and supported by the learned, and adopted by the highest legal authorities, to be constructively disowned and abandoned by his sponsors and become a willing votary of slow cremation, is a career so unusual as to entitle a short biographical sketch. In Otto *v.* Linford the cushion was the pith and marrow of the invention. There was to be between the explosive mixture and the piston either a body of air, of products of combustion, or a mixture of both. Upon that point Sir F. Bramwell, Mr. Imray, and all the learned judges were in harmonious accord—that was the principle, the idea, the something very particular which was to regulate, detain, or make gradual what otherwise would have been an explosion. Now in the mind of Mr. Justice Pearson, nothing can be more opposed to the idea of a pure, incombustible layer of air than the statement of Dr. Otto, in which, so far from saying there will be no combustible matter near the piston, he says most distinctly that when the charge enters, the combustible particles of that charge will be dispersed through the cylinder. *Sic transit* the cushion, his epitaph uncertain as his *resurgam* in the higher Court; but the learned Judge made a further remark: "Whether that dispersion is in air or products of combustion, the results are equal;" and in this counsel, in a brilliant defence, concurred: "residuum was no more than anything else." Eminent chemists, I take it, are agreed that the influence of inert gas in the composition of the mixture is to effect a diminution of temperature and to reduce the translation velocity of the molecules, the results varying with the nature of the excess, and in the duration between inflammation and maximum pressure, products of combustion as constitutents of the mixture have a far greater retarding influence than the same proportion of atmospheric air. Tables founded upon experiment have been published showing the several ratios, and without any evidence upon the point the conclusion of the learned Judge was not justified, that "whether you draw in air or whether you leave in residuum, you produce directly the same effect." The point is of importance. Professor Dewar fixes it at 5 per cent., the proportion of coal-gas next the piston in Clark's engine. Now 1 of coal-gas entering into combustion with 20 of residuum would supply more humour than conviction, because the professor found the ratio of gradation at 10, 7, 5, and thought the percentage of coal gas entering the cylinder was too small to admit of combustion if the charge had been uniformly diluted—a process of reasoning difficult to follow; but this is clear, if a certain proportion enters into combustion in Clerk's or any other engine, and does not do so in Otto's, the results from the difference in the excess are so widely different as to the velocity that it is manifestly unfair to ascribe equal virtues to both, and better results should not be denied the privilege of user because Otto claims the retarding influence of residuum which now exists in his and every well-made engine only so far as it cannot be got rid of. AIR.

December 29th.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—George A. H. Michell, chief engineer, to the Asia, for the Shah.

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending Dec. 26th, 1885:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 13,204; mercantile marine, Indian section, and other collections, 3853. On Wednesday and Thursday, admission 6d., from 10 a.m. to 4 p.m., Museum, 440; mercantile marine, Indian section, and other collections, 32. Total, 17,529. Average of corresponding week in former years, 18,763. Total from the opening of the Museum, 24,513,994.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, December 19th.

THE opening of Congress has brought out the champions for and against the suspension of silver coinage, the advocates of high and low tariff, and the extremes on several other questions that are to be settled, if possible, in Congress this winter. The anti-silver men are compactly organised, and are confident that the idle 165,000,000 dols. of silver will not be increased. They have the President with them, the banking interests, and a large and very influential element of business men and Chambers of Commerce; but, on the other hand, there are the great mass of the country, who favour the silver dollar, and who, on a square vote, would decide in favour of it.

Revenue reformers have been extremely active during the past month or two, and have the country pretty well organised for another onslaught for lower duties. The Administration is also with them, although the President and his Cabinet are very cautious in their expressions, knowing that public sentiment is pretty evenly divided. The manufacturing interests are on the alert, and every movement of the revenue reformers will be met with a vigour they have always been met with.

The steady upward movement in iron and steel still continues. Stocks are low at furnaces and mills, and orders are in hand for from one to three months' production. The weekly production of iron is between 90,000 and 95,000 tons, or over one quarter more than was made a year ago. A further increase will be ventured upon during the winter, and if no falling off in consumption takes place, the present prices will be strengthened by March 1st. Large and small consumers are willing now to buy stocks ahead, a course they have been unwilling to pursue for over a year. This, in addition to the actual scarcity of iron, is helping prices. Work on steel mills throughout the country is being pushed rapidly. The combination of five manufacturing firms was effected this week for the purpose of making steel nails out of old steel rails by a new and valuable process, for which the successful inventor will realise 2,000,000 dols. The Western steel nail makers are increasing their production slowly, and are selling at 2.50 dols. Orders are less urgent for nails. The Western nail makers have not 700 machines at work. The manufacturers are confident of winning, as the demand throughout the winter is moderate. The tone of the market is very firm in all branches. Usually during the holidays very little business is transacted, but at the present time more orders are coming in than were looked for at the first of the month. Steel rails are very firm at 35 dols. No old rails are to be had. Offers are made for 15,000 tons in small lots at 20 dols., but they will no doubt bring 20 dols. or 21 dols. at tide water if they are to be had. Bessemer pig is under fair inquiry at 20 dols.; 20 per cent. spiegeleisen 27 dols. Lake ore has advanced 50c. in Western Pennsylvania. Native ore is firm.

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

(*From our own Correspondent.*)

THE meetings of 'Change this week have been only quiet affairs. Purchasers have been inclined to prolong the holidays as much as possible, and have therefore kept out of the market. The works that have resumed operations are few in number. The majority will remain closed until Tuesday of next week.

The demand for black sheets keeps up well, since the galvanisers seem to be making almost unlimited shipments to South Australia, South America, India, and some other markets. Production of black sheets is being increased by the entry into the trade of new firms, and this consequently keeps down prices. £6 7s. 6d. to £6 10s. is mostly asked for singles, though some transactions are mentioned at £6 5s. Doubles are £6 12s. 6d. upwards; and lattens, £7 12s. 6d. to £7 15s. The list iron houses quote £9 to £9 10s. for singles, while the thin sheet makers quote for working up qualities, £10 to £11; and for stamping qualities, £11 to £12.

Morewood and Co.'s black sheet prices, f.o.b. Thames or Mersey, are:—Ordinary brands: £8 for 20 b.g.; £9 10s. for 24 g.; £11 for 26 g.; and £11 10s. for 28 g. Woodford Crown brand: £9 10s. for 20 g.; £11 for 24 g.; £12 10s. for 26 g.; and £13 for 28 g. Woodford best are £11, £12 10s., £14, and £14 10s., according to gauge. For double best an additional 30s. per ton is required, and for treble best a still further 40s. Mild steel close annealed sheets are £13 for 20 g.; £14 10s. for 24 g.; £16 for 26 g.; and £16 10s. for 28 g. Charcoal sheets are £16, £17 10s., £19, and £19 10s., according to gauge.

A feature of the market which induces much hope for the future of trade is the lowness of consumers' stocks alike at home and abroad, whilst the requirements of America, India, and Australia are steadily mending. If the improved American demand should continue and largely develope, the effect upon this district would be most beneficial.

It is becoming increasingly necessary for the makers of branded iron to turn their attention to medium qualities. Prices of marked iron are nominally upheld at £7 10s., the price that has ruled for nearly three years, and makers say that they have no intention to alter this figure. Medium qualities of bar iron range from £6 10s. down to £6, and common sorts from £5 10s. down to £5 5s. and even £5. Orders for good quality bars for Australia, North and South America, and some other markets have lately been received by Messrs. Noah Hingley and Sons in tolerable numbers.

The quarterly meetings are fixed for January 13th in Wolverhampton, and January 14th in Birmingham.

Messrs. Noah Hingley and Sons, Netherton Ironworks, Dudley—whose principal, Mr. Benjamin Hingley, M.P., is president of the South Staffordshire Ironmasters' Association—quote Netherton Crown best and Netherton Crown best horseshoe bars, £7 10s.; best rivet, £8; double best plating bars, £9; double best Crown bars, £8 10s.; and treble best ditto, £9 10s. These quotations apply to rounds and squares ⅝in. to 3in., and to flat bars 1in. to 6in. For angles up to 8 united inches, an additional 10s. per ton extra is quoted, and for tees an additional 20s.

The plate trade is quiet, and the orders are going mostly to firms in the North of England, North Staffordshire, and other competing districts. Ordinary qualities of boiler plates are £8 to £9, and superior sorts £9 to £9 10s. Tank plates are £7 upwards.

Engineers here note with much satisfaction that rolled girders are now to be obtained from the North of England in large quantities, and of 18in. by 7in. sizes, at prices which are in no degree higher than the lowest rates at which the imported Belgian girders are offered. It is satisfactory that soon girders of 20in. by 8in. will be available of native manufacture. Certainly, if English makers can fill orders as rapidly as required, there should be no excuse for continuing to buy either from Belgium, Germany, or France.

Sales of pig iron in the next two or three weeks are likely to be considerable, and for many brands present prices will be accepted for deliveries over the ensuing six months. Northampton and Derbyshire pigs are an average of 38s. to 40s. at stations; Lincolnshire are quoted 41s. to 41s. 6d.; and Barrow hematites are quoted 55s. Staffordshire makers' quotations figure at 55s. to 60s. for all-mine hot air pigs, and 75s. to 80s. for cold air; 42s. to 45s. for part-mine pigs, and an average of 35s. for cinder iron.

Prices for coal stand at 5s. to 6s. for common forge coal, 6s. 6d. for superior, 7s. to 7s. 6d. for mill, and 8s. to 10s. for furnace sorts. Cokes are quoted 22s. for Durham foundry sorts delivered here, 18s. 6d. for Welsh foundry, and 14s. to 14s. 6d. for South Yorkshire qualities. Northampton ironstone is 5s. 6d. to 6s. delivered.

The question of wages in the sheet mills is again to the front. Messrs. J. B. and S. Lees, of the Albion Ironworks, West Bromwich, have now given the men at their thin sheet mills notice for a revision, the reduction amounting to 10 per cent. The men turned out on strike, but other hands being plentiful, the mill is again at work.

The North Staffordshire iron trade has passed through a quiet week. Prices are now decidedly less remunerative than they were twelve months ago. In January, 1885, prices were nominally:—Crown bars, £5 12s. 6d.; best, £6 2s. 6d.; plates, £7 to £7 5s., delivered Liverpool or equal. Quotations at date are: Crown bars, £5 2s. 6d. to £5 5s., best 10s. more; plates, £6 10s. to £7. The home and continental demand, which has been dull throughout the year, shows no signs of an early revival; but in the Canadian demand indications of an improvement are observable, some good inquiries for spring shipments being now in the market.

The strike in the wrought iron tube trade in Worcestershire is continued. The employers desire a 10 per cent. reduction, and a return to the ten hours' system. The operatives have offered to accept a reduction of 5 per cent., but this concession the employers have declined.

Machinery in the lock trade is proving a great success. A demand larger than can be met is coming forward from the Australias for machine-made rim locks, and Willenhall firms who have put down special plant for this business are oppressed with orders. An important firm of lock manufacturers at Willenhall is making arrangements for opening up a vigorous competition in the Australian and other export markets against the American rim lock. It is made with a cast iron ornamental case, and all the internal parts, including the very clever and valuable reversible bolt, are made to template. The Willenhall firm speak very confidently of their prospects, and state that they shall undersell the American article very considerably, at the same time that they offer a lock in every way equal.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Tuesday's markets practically brought to a close, for the year 1885, business operations in the iron and coal trades of this district. There was, however, but little attempt at actual business in the iron market, and, except a temporary pressure for supplies of house fire coal in the interval between the Christmas and New Year stoppages of the collieries, there was only a moderate demand generally reported on the Coal Exchange, and the attendance on both Exchanges was small. So far as prices were concerned, they were without alteration; but in the iron market there was no business offering to actually test values, and quotations were consequently little more than nominal, whilst for coal late rates were only being maintained, and scarcely this in some of the inferior descriptions of fuel.

The year closes upon a twelvemonth's continuous depression in trade and excessive lowness of prices. In nearly all branches connected with the engineering, the iron or coal trades, extreme competition for business has entirely removed any margin for profitable remuneration upon business or manufacturing operations, and in most instances the past year's trading will present but a very discouraging record.

In the iron trade the year opened with a despondent outlook which has been more than fulfilled. Prices, which were then thought to have touched their lowest, have had to give way still further, until makers and manufacturers realising the futility of attempting to stimulate business even at prices which do not cover the cost of actual production, have been driven as a last resort to a restriction of their output. In the pig iron trade poorer results than had been known for a considerable time past were brought out of the opening business of the year, and prices which started on a quoted basis of about 41s. up to 42s., less 2½ per cent., for local and district brands delivered equal to Manchester, were gradually forced downwards until 1s. to 1s. 6d. per ton below nominal current rates was being openly quoted to secure orders. As the year progressed the disturbed state of political affairs abroad added a still further element of unsettlement to the market, and with a continued absence of any weight of buying, prices were forced down lower and lower until 37s. 6d. to 38s., less 2½ per cent., represented the prices which in some instances were being taken to effect sales. About September reports of an improved American trade began to be circulated in the market, and the excessive lowness of prices evidently offered a temptation for speculative buying, and heavy sales were made, which gave a sudden, but only temporary, upward movement to prices. The market was not backed up by any improvement in the iron-using branches of industry, and very soon relapsed into almost as stagnant a condition as before, except that the previous downward tendency of prices had received a check. With the close of the year, the political excitement of the elections to a very considerable extent diverted attention from business, and the market had scarcely resumed its normal condition when preparations for the usual stock-taking and holidays became the final obstructionists in the way of business of any weight being done. With the present general suspension of business it is difficult to say what prices really are; but the large increase of stocks in the iron districts of Scotland and the North of England naturally gives a weak tone to the market. Nominally, about 39s. to 39s. 6d., less 2½ per cent., are the quoted rates for the best local and district brands; but there are sellers who would take quite 1s. under these figures; and although prices still show some recovery from the lowest point of the year, they are fully 2s. to 2s. 6d. below what makers were asking when the year commenced.

So far as purely local requirements are concerned, the business doing in hematites in this district is of no very great weight. All through the year prices have been exceptionally low, and on a large proportion of the sales not more than 51s. to 51s. 6d., less 2½, has been got for good foundry qualities delivered into this district. During the last three months an upward movement has taken place as the result of fairly large orders for shipment, principally to America, and closing prices are about 53s. 6d. to 54s., less 2½, but with little or no business doing at these figures.

In the manufactured iron trade the tendency during the whole of the year has been persistently downwards. Even the temporary spurt in the pig iron trade during the autumn had no appreciable effect upon finished iron, and with the exception that in some qualities of sheets makers during the autumn were able to get advanced rates, prices have gradually fallen from about £5 10s. to £5 11s. 3d. for bars—the quoted price for delivery into the Manchester district in January last—to about £5 2s. 6d. and £5 5s., the actual selling price with the close of the year. Generally forges have been but indifferently employed from hand-to-mouth, and some works have been stopped entirely. Here and there, however, one or two large concerns have been well supplied, and during the past six months the production of manufactured iron and steel by the Pearson and Knowles Company, at Warrington, has exceeded 50,000 tons, which is probably the largest output of any single works over a similar period, either in this or any other country. The prices, however, at which the bulk of this work has been secured have been below cost, and the year finishes without much work in hand.

The past year, as regards the engineering trades, has been characterised by a continued slackening down in the weight of work giving out, and an increasing keenness of competition to secure orders, which to a very large extent has resulted in works being carried on more with the object of keeping their staff of men together in the hope of better times than because there has been any actual profit to be derived from the trade which has been obtained. In the locomotive building trade a fair amount of activity has been maintained in finishing old orders, but this year closes with less new work giving out and fewer inquiries than probably has ever been known before. Special tool makers have also been moderately well employed, but a good deal of the work has been in connection with plant and tools for ordnance work and the equipment of Government arsenals and shipyards, whilst the large works of Sir Joseph Whitworth and Co. have been busily employed on gun material and orders in connection with the construction of new war ships, but this is an activity which can scarcely be classed in the run of ordinary trade. The leading cotton machinists have had a fair weight of orders coming into their hands; from the Oldham district there has been a moderate amount of work given out for the filling of new mills and the refitting of old ones. Tolerably large orders for machinery have also come into this district from Scotland and the Midlands, but a large proportion of the work has been for abroad. Boiler makers, with the exception of one or two established firms of repute, have had no great weight of orders in hand; in heavy engineering work there has been very little doing, and small engine builders generally have been but indifferently employed. The returns as to employment issued by the engineering trades union societies have afforded further only too ample proof, were it needed, of the growing depression in trade. All through the year there has been a constantly increasing number of members coming upon the books for out-of-work support. In the Amalgamated Society of Engineers the number of unemployed members actually in receipt of out-of-work benefit has gone on steadily increasing month after month, from about 6 per cent. in January last to about 8 per cent. of the total membership with the close of the year, and in the Steam Engine Makers' Society a similar increase of out-of-work members, though on a lessened scale, has also been reported. The rapid decline in trade and the extreme competition, not only from home but also from foreign manufacturers, has rendered some reduction in the cost of engineering and machine work an absolute necessity, and it is now generally understood that after the turn of the year there will be an extensive general reduction in the rate of wages now being paid in the various branches of the iron and engineering trades throughout the country. As a result of this, it is reasonable to anticipate that a larger share of orders and a more general employment of workmen will be thus secured. In fact, such a step has become imperative as the only course now open by which alone the trade of the country can be held together, and work found for the operatives themselves.

The coal trade has naturally been seriously affected by the depression which has prevailed throughout the principal coal-using branches of industry. In house-fire coals the demand and prices have fallen and risen with seasons of the year, and at the close are practically in much the same position as they were at the same period twelve months back. Other sorts, however, for iron making, steam, and general manufacturing purposes, have been plentiful in the market all through the year, with the tendency of prices almost continuously in the favour of buyers, the result being that some of the inferior descriptions are, with the close of the year, fully 6d. per ton lower than they were twelve months ago. Wages questions have come into considerable prominence during the past year. In the West Lancashire district unsuccessful efforts were made to establish a sliding scale; then combinations for a restriction of the output were attempted, followed subsequently by a futile agitation for an advance of 10 per cent. Except, however, that in the Manchester district wages were reduced 10 per cent. in the summer, and then advanced 10 per cent. in the winter, there has been no real alteration in the rate of wages in the Lancashire district, and they remain practically the same as when the year commenced.

Barrow.—There has been a quiet tone in the hematite pig iron trade during this week, and business will probably continue slow until there has been a complete resumption of activity at the several works at which there has been a temporary cessation of business during the holiday season. There is a fair demand for all classes of iron, although for the moment the inquiry has fallen off; but negotiations are going on all round, and the probability is that before the spring very large parcels of iron will be sold for forward delivery. Stocks remain large in many cases, but in others makers have fully disposed of the iron which they held some time ago. There is no change to note in the price of iron. No. 1 Bessemer is quoted at 45s. per ton net at makers' works, prompt delivery; No. 2, 44s. 6d.; No. 3, 44s. per ton; and forward deliveries at 1s. to 2s. per ton over these rates. Forge iron is in smaller demand than Bessemer qualities. Steel makers are quiet for the moment, industrially speaking, but with the new year there are indications of a greater renewal of activity than has lately been experienced. Shipbuilders are still very short of orders, and the enquiries from all quarters are limited in number, and do not represent any great tonnage of building. Engineers are not well off for orders, either in the general or marine departments, and the prospect is for the present very poor. Iron ore finds a poor market at unchanged prices. Coal and coke in quiet consumption. Shipping indifferently employed.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

The Cleveland iron market, held at Middlesbrough on Tuesday last, was but thinly attended, and few sales were made. It was therefore not easy to ascertain the precise value of pig iron. Prices were clearly below those accepted last week, and some holders, anxious to clear out before the close of the year, were selling No. 3 g.m.b. at 31s. 3d. per ton for prompt delivery. The usual quotation given by merchants was 31s. 6d. per ton; but makers would not accept so low a price. Owing to the continued accumulation of stocks and the diminished shipments, the tone of the market was gloomier than ever; buyers being without confidence as to the future, naturally declined to commit themselves.

There have been no transactions in warrants of late, and quotations remain at 32s. 3d. to 32s. 6d. per ton.

The stock of pig iron in Messrs. Connal and Co.'s Middlesbrough store is growing rapidly. On Monday last the quantity held was 136,832 tons, being an increase for the week of 4116 tons. At Glasgow their stock has increased nearly 11,000 tons during the last fortnight.

Shipments of pig iron proceed at a rate which is far from being satisfactory. Only 50,943 tons had been exported on Monday last since the 1st of December, as compared with 64,974 tons in the corresponding portion of November.

There is little to report with regard to finished iron, almost all the works being closed until next week. The prices quoted are unaltered, being as follows:—Ship plates, £4 10s. to £4 12s. 6d. per ton; angles, £4 5s. to £4 7s. 6d.; and common bars, £4 15s. to £4 17s. 6d.; all free on trucks at makers' works, less 2½ per cent. discount. Steel manufacturers are somewhat busier than they were. The price for plates of ordinary quality is £6 12s. 6d. per ton at works, and for angles it is about £6 5s.

The discussion on the peculiarities of steel which has been in progress during the last three or four weeks in the columns of The Engineer is naturally exciting great interest in all the Northern iron trade centres. Now that the ball has been set rolling, it does not appear likely to stop for some time. Various other instances of unexpected behaviour on the part of steel plates and angles are cropping up day by day; instances which perhaps would not have been mentioned but for the curiosity which manifests itself everywhere to know the worst. It seems that some, but not all of the recent failures, have been traced to the presence of phosphorus in excess, as much as ¼ per cent. having been in some cases detected. This does not necessarily implicate the basic process. On the contrary, that is the only process by which that specially obnoxious element can be eradicated if present in the materials charged. Phosphoretted pig or scrap iron introduced into either the Bessemer acid-lined converters, or into the Siemens acid-lined furnace, must result in phosphoretted steel, as in neither case is there anything to eliminate it. Steel which is quite pure enough for rails, or even sleepers, may be totally unfit for plates or angles, and perhaps this fact has been insufficiently recognised. It is said that Lloyd's Committee have issued notifications to the effect that for the present they will be unable to accept basic steel in ships built under their survey. This action is strongly condemned by many persons totally unconnected with the basic steel interests as, at all events, premature until there has been a public investigation into the complaints which led to it. It is felt that whatever failures there may have been, they have not been conclusively traced to the basic more than to any other process. Only last week a steel boiler plate supplied by one of the largest and best known Scotch companies, and undoubtedly made by the Siemens process, was being manipulated at the works of an East Coast engine and boiler builder. The plate had been furnaced and bent into the required form and was left to cool. Returning in a short time the workmen found that a piece of considerable area had flown out of the middle of the plate, leaving a corresponding hole and rendering the plate useless.

It is understood that Mr. Maginnis, the hero of the hour, is preparing a paper, to be read before one of the Northern Institutions of Engineers at an early date. He will, no doubt, set forth therein his own views and conclusions as regards steel plates and steel boilers, as developed in the light of the discussion which his original communication has evoked.

The new decision of Lloyd's Committee to exclude Bessemer basic, and perhaps Bessemer acid steel from ships, will, if persisted in, be a special hardship to certain firms who have expended large sums of money, and taken almost endless trouble, to establish works for the object of manufacturing those materials by those processes, especially as no more blame can be attached to most of them, so far, than to any other steel makers.

In favour of makers of steel boiler-plates by the Bessemer acid process, it may be pointed out that the earliest steel boilers, and those concerning which there is longest experience, were made of this material. For instance, the boilers again and again referred to at meetings of the Iron and Steel Institute by Mr. Wm. Richardson, of Oldham, as used by his firm, cannot now be less than twenty years old. Besides this there is the very extensive experience in locomotive boilers by the London and North-Western Railway Company, at Crewe. All their locomotive boilers are understood to have been made of Bessemer acid steel in all parts except the inside fire-box, which is of copper. These and a number of other facts ought to afford consolation to the makers of Bessemer acid steel, and ought to prevent any precipitate action in the direction of tabooing any particular kind of steel until more is known as to the real and complete circumstances of recent failures.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

In the iron trade business has been quiet this week, in consequence of the holidays. The main feature of interest has been the issue of the statistics of the trade for the past year. Four years had elapsed since complete returns were made by the ironmasters, and the reports during that time were carefully estimated in those departments where actual returns were not available. It was almost impossible that the estimates should be thoroughly accurate, and the full returns made by the ironmasters on this occasion of the production and stocks in their hands, show that in the past two years, at least, both the production and the makers' stocks had been returned at less than the real figures. The consequence has been that the present report is more unfavourable than was anticipated, the stock of pig iron being at least 100,000 tons above the most liberal calculations that had been made. The output of the hematite furnaces is materially greater than that of ordinary pig iron, and the old basis of calculation has therefore been disturbed. Availing themselves of the ironmasters' returns, the Scottish Pig Iron Trade Association has issued the following official report of the trade from Christmas, 1884, to Christmas, 1885:—

	1885. Tons.	1884. Tons.	1885.
Production	1,003,562	988,000	Inc. 15,562
Consumption—In foundries, as per returns received ..	152,597	237,000	
In malleable and steel works, as per returns received ..	243,022	231,000	
Total	395,619	468,000	Dec. 72,381
Exports—Foreign, less 5700 tons English iron transhipped	267,456	319,463	
Coastwise	162,299	197,251	
Railway to England	14,859	17,286	
Total	444,614	534,000	Dec. 89,386
Stocks—In Connal's stores ..	665,688	579,423	
In makers' hands	384,995	241,577	
Total	1,050,683	821,000	Inc. 229,683

	1885.	1884.
Number of furnaces in blast on Dec. 25	91	93
Average number of furnaces in blast for the year	90	95
Average price of mixed numbers g.m.b. warrants for the year	41/10	42/1½
Highest price of mixed numbers g.m.b. warrants	43/11½	44/7½
Lowest price of mixed numbers g.m.b. warrants	40/7½	40/10
	Tons.	Tons.
Quantity of malleable iron and steel made in Scotland	441,366	387,000
Consumption of Cleveland and Cumberland pig iron in Scotland—		
In foundries..	270,000	224,000
In malleable iron and steel works	195,000	145,000
Total	465,000	369,000

The unfavourable character of the statistics had the effect of causing a drop in the values of warrants from 41s. 7d. cash, which was the closing price on the day before Christmas, to 40s. 8½d. when the market reopened on Monday. In the afternoon, however, the price recovered several pence a ton. Business took place on Tuesday forenoon at 40s. 11½d. to 41s. 11d. cash, the afternoon quotations being 41s. ½d. to 40s. 11d., closing with buyers at 40s. 11½d. cash. Business was done on Wednesday between 40s. 9½d. and 40s. 11d. cash. To-day—Thursday—there was an improvement to 41s. 2d., and the closing price for the year was 41s. 1½d. cash.

The values of makers' iron were also somewhat depressed by the annual statistics. They are as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 46s.; No. 3, 43s. 6d.; Coltness, 50s. and 46s.; Langloan, 47s. and 44s. 6d.; Summerlee, 51s. and 45s.; Carnbroe, 45s. and 43s.; Calder, 50s. 6d. and 43s. 6d.; Clyde, 45s. and 42s.; Govan, at Broomielaw, 41s. 9d. and 39s. 6d.; Shotts, at Leith, 47s. 6d. and 46s. 6d.; Carron, at Grangemouth, 47s. 6d. and 46s. 6d.; Kinneil, at Bo'ness, 44s. and 43s.; Glengarnock, at Ardrossan, 46s. 6d. and 42s. 6d.; Eglinton, 42s. 6d. and 39s. 6d.; Dalmellington, 44s. and 40s. 6d.

The Scotch steel makers are still maintaining their advanced prices, although they have lately lost some orders in consequence. One of these orders has been placed by a Glasgow firm with a German house, ship plates being the articles in question, and they are to be supplied at 10s. a ton under the Glasgow quotations.

It is reported that some Belgian girders which recently arrived for use in the erection of a new railway station at Paisley have been condemned, in consequence of the iron being not equal to that specified in the contract.

The coal trade is in a somewhat awkward predicament at present. Several of the large masters who gave an advance of 6d. a day to the miners about a month ago have been doing a large business, while others who declined to give the increase in consequence of being unable to obtain an advance in the prices of coal have had their pits idle through a strike of the workmen since the beginning of the present month. The coalmasters of Lanarkshire met in Glasgow on Monday to consider a proposal to withdraw the recent advance of 6d., but as several of the more influential colliery owners failed to attend the meeting, it separated without arriving at any decision. Later the same day the Airdrie and Slamannan masters, whose men have been on strike, met in the Royal Exchange, and after discussing the situation, they determined to adhere in the meantime to their former resolution not to concede the advance. Some of the Airdrie and Slamannan miners have been working several days this week at the old rates, being anxious to make some money for the New Year holiday. Unless the men should give way, the wages question will likely have to be reconsidered within the next week or ten days.

Taking into account the state of matters above explained, the coal shipments of the past week have been fairly satisfactory in amount. They embraced 25,228 tons at Glasgow, 1117 at Greenock, 250 at Port Glasgow, 3156 at Irvine, 7279 at Troon, 7528 at Ayr, 460 at Leith, and 6018 at Grangemouth.

WALES AND ADJACENT COUNTIES.

(*From our own Correspondent.*)

The great explosion at Mardy Colliery is, of course, the leading subject of discussion all over the district. The loss will very likely amount to eighty-one or eighty-two men and boys, as several are in a sad condition. Mardy Colliery was sunk by the late Mordecai Jones, of Brecon, and sold to the firm of Lockett and Co., of whom Mr. W. Thomas, Brynawel, Aberdare, is the representative and mining engineer. The colliery is a fine one, and has all latest and best appliances. It has been visited by most of the leading coalowners and mining engineers, and has been commended highly by such authorities as Sir George Elliott and Sir W. T. Lewis. As regards cause, scientific opinion leads to the coal-dust theory of Mr. Galloway; others, that a fall having taken place, masons were arching with a comet light to aid them, and that barometrical depression taking place, ignition and explosion followed. I submit, with all due deference to practical men, that falls are often due to the action of gas, and that a great fall should at once suggest extreme caution. Again, as to the coal-dust theory, a patent was taken out by Lewis and Kirkhouse some time ago for a capital contrivance to water roadways. It will be of interest in the course of the inquiry to know if this is in practical use. The damage done in the downcast is being rapidly repaired, and this week I expect the pit will be at work.

The Miners' Provident Fund, which is in excellent working order, is now maintaining 110 widows and 190 children due to those single accidents which are incessantly taking place in the coal district. So this disaster will necessitate some outside help from the public, and I am glad to see that this is being freely accorded. There is little doing in the coal trade beyond the ordinary run. Totals will, of course, be far below average on account of Christmas holidays and the Mardy accident. Still reports at Cardiff and Newport are favourable, and unless the weather should interfere with shipments, as it promises to do, the total this week will be moderately good both for steam and house coal. Small steam is quiet. Breakages at Plymouth collieries, unattended with injury to the men, have caused some delay in work and caused consequent distress. This has led to an application for the use of a fund contributed to from all parts of the country in aid of distressed children, but no decision has yet been made. Cyfarthfa colliers are working better this week.

Some large cargoes of iron and steel were shipped last week. From Newport 4133 tons were sent, and from Cardiff 4800 tons. The principal items from Newport were India, 1900 tons; Paysandu, 1050 tons; Buenos Ayres, 530 tons; Santos, 653 tons.

Iron ore is coming to hand slowly, scarcely half of the usual consignments have been had, but the holidays doubtless are the chief cause. It will be seen from exports that Wales is still doing a moderate steel rail trade, even working as it does about half time; but there is a prospect of improvement, and if China and Congo were opened out there might be something like a revival of those good old days when the Americans and Russians were great buyers of the Crawshays and Guests. I remember the time when Penydarran and Cyfarthfa sold large quantities of bar iron to Turkey. Penydarran Works are now swept completely away, and the site is a permanent circus! As for Cyfarthfa, it is questionable whether it has any "Turkey bar" trade now.

An interesting letter has been published by Mr. Spence, I see, referring to the tin-plate trade. Mr. Spence has, or had, a connection with Pentyrch tin-plate works, and is a leading authority on the subject. In his letter he states that there are eighty-four works in Wales, and that more than thirty of them have failed during the last five years. Mr. Spence dates the reverses of the trade from 1879, when the American boom sent up coke plates to 30s., and a speedy reaction followed, and variation ever since. The fear he apprehends now is that Germany will come into the field as competitors; but we must bear in mind this fact, that America did her best to compete, but failed, and that we owe our position to the special qualities of our coals. Unless Germany is so favoured we have not much to fear.

The tin-plate trade is not quite so brisk, and makers are satisfied to make a small abatement of 3d. per box for the principal varieties. Cokes, Bessemers, and Siemens ternes are not in free demand; wasters are better. Ordinary cokes are being bought at last quotations freely.

In the matter of exports, Swansea figured well last week by sending away the largest total on record—5000 tons to the States, New York, Philadelphia, &c. The New Year opens with some clouds about the horizon. Two or three works are stopped and a couple are in the market, and fears are entertained as to the maintenance of the union. Apart from this there is a prospect of a good foreign demand and of firm prices.

Stock-taking will now begin, and in the next few weeks we can more easily forecast prospects than at present.

Notice has been posted at Briton Ferry Ironworks, and a stoppage will take place this week; whether temporary or not remains to be seen.

It is arranged that the first coal train from Wales to London shall go through the Severn Tunnel on the 9th of January. The officials have been busily engaged making arrangements.

LAUNCHES AND TRIAL TRIPS.

On Tuesday, the 22nd ult., a steel steamer, the Kaisow, of 3000 tons register, was launched from the shipbuilding yard of Messrs. Joseph L. Thompson and Sons, North Sands, Sunderland. This vessel, which has been built to order, forms the latest addition to the fleet of the China Shippers' Mutual Steamship Company, London, trading regularly between that port and China. Her length is 362ft., breadth 41ft., and depth 24ft. 6in. She has the highest class at Lloyd's under the three-deck rules, with long bridge deck amidships enclosing cabins, and having water ballast fore and aft on the cellular system. Every modern improvement has been introduced in the construction and equipment of the vessel. The engines are of the triple expansion type by Messrs. Thomas Richardson and Sons, of Hartlepool, of 2400 indicated horse-power, and are calculated to give the vessel a speed of 13 knots. She is also fitted with teak decks, direct steam windlass, double steam winches, steam steering gear, and steering telegraph, and will have accommodation for a limited number of first-class passengers, a Board of Trade certificate having been provided.

The steamer Capella made her trial trip on the 3rd ult. She is built by Messrs. Martens, Olsen, and Co., of Laxevag, Bergen, Norway, and is specially intended for the tourist traffic on the North Cape. Her dimensions are as follows:—Length between perpendiculars, 192ft.; extreme breadth, 28ft. 6in.; depth of hold, 14ft. 8½in. She is fitted with Martens, Olsen, and Co.'s steam-winch, Clarke, Chapman, and Co.'s windlass, and Davies' steam-steering gear. Water ballast on the cellular system. Engine, 135 nominal horse-power, also made by Messrs. Martens, Olsen, and Co. A speed of 12½ knots was easily obtained. The same firm have on the stocks another passenger boat intended for the conveyance of tourists to the North Cape.

NEW COMPANIES.

THE following companies have just been registered:—

Buenos Ayres and Belgrano Tramway Company, Limited.

This company was registered on the 22nd ult. to acquire the tramway and other property of the Belgrano Tramway Company (Empresa de Belgrano) in Buenos Ayres, and generally to carry on the business of a tramway and omnibus company. The capital is £217,500, divided into 27,500 preference and 16,000 ordinary shares of £5 each. The subscribers are:—

	Ordinary Shares.
A. J. H. Robertson, 41, Coleman-street, chartered accountant	1
J. B. Parry, Well-walk, Hampstead, accountant	1
A. T. Hooper, 57, Moorgate-street, merchant	1
C. Beringer, 57, Moorgate-street, accountant	1
W. Doherty, 6, Great Newport-street, W.C., printer	1
J. W. Hepburn, 7, Pancras-lane, law stationer	1
L. Frankes, 19, Rue de Provence, Paris, merchant	1

The number of directors is not to be less than three nor more than seven; qualification, £500 in shares or debenture stock; the first directors are appointed by the subscribers; remuneration, £875 per annum.

James Simpson and Co., Limited.

This is the conversion to a company of the business of manufacturing engineer, carried on by Mr. James Simpson, at the Engine Works, Grosvenor-road, Pimlico. It was registered on the 19th ult. with a capital of £71,000, in £10 shares. The subscribers are:—

	Shares.
*J. Simpson, 101, Grosvenor-road	1
*A. Telford Simpson, 38, Parliament-street	1
*C. L. Simpson, 101, Grosvenor-road	1
*T. B. Simpson, 1, Victoria-mansions, S.W.	1
E. P. Simpson, 13, Second-avenue, West Brighton	1
*J. G. Mair, 101, Grosvenor-road, engineer	1
*W. J. Brown, 101, Grosvenor-road	1

The number of directors is not to be less than three nor more than seven; qualification, £200 in share or stock. The first are the subscribers denoted by an asterisk.

Cranleigh Water Company, Limited.

This company was registered on the 19th ult. with a capital of £5000, in £5 shares, to supply water to the village and parish of Cranleigh, Surrey. The subscribers are:—

	Shares.
Rev. J. H. Sapte, Cranleigh	10
Rev. J. Merriman, Cranleigh	10
W. Welch, Cranleigh, assistant-schoolmaster	50
S. Crompton, Cranleigh, physician	20
S. Rowland, Cranleigh, draper	20
G. Holdaway, Cranleigh, station master	2
E. Holden, Cranleigh, builder	
W. B. Hankey, Cranleigh	10
T. T. B. Hankey, Cranleigh, Captain R.N.	20
A. A. Napper, Cranleigh, surgeon	30
J. Hardy, Cranleigh, assistant-schoolmaster	20
A. Napper, Guildford, surgeon, retired	20

Registered without special articles.

Edgbaston and Harborne Tramways Company, Limited.

This company proposes to acquire the rights and interests of the promoters of the undertaking authorised by the Edgbaston and Harborne Tramways Order, 1883, confirmed by the Tramways Order Confirmation (No. 2) Act, 1883. It was registered on the 21st ult. with a capital of £100,000, in £10 shares. The subscribers are:—

	Shares.
Colonel E. J. L. Twynam, Great Malvern	15
C. E. Mathews, Birmingham, solicitor	15
T. Smith, Handsworth, Birmingham, director of a company	15
J. Wilson, Birmingham, contractor	15
R. Pearsall, Moseley, Birmingham, contractor	15
J. James, Birmingham, solicitor	1
J. A. Darby, Birmingham, clerk	1

Registered without special articles.

Hayes' Patent Chair Works and Cabinet Manufacturing Company, Limited.

This is the conversion to a company of the business of chair and furniture manufacturer carried on by Mr. James Hayes, trading as Hayes and Company, at 36A and 95, Central-street, St. Luke's. It was registered on the 18th ult. with a capital of £10,000, in £1 shares. The purchase consideration is £2000, one-half being payable in fully-paid shares. The subscribers are:—

	Shares.
A. Mountcastle, 72, Shepperton-road, Islington, commercial traveller	5
J. H. Pritchard, 469, Battersea Park-road, chemist	1
S. Hart, 69, Wigmore-street	1
T. Harrison, 5, Brick-hill-lane, Upper Thames-street, wine merchant	1
C. J. Bryce, 10, Miles-lane, London Bridge, engineer	1
A. Davy, 1, Beaconsfield-terrace, Brondesbury, cigar importer	1
C. C. Utton, 39, Grove-road, Holloway	1

The number of directors is not to be less than three nor more than seven; qualification, 50 shares; remuneration, £52 10s. per annum, to be increased to £105 in any year in which £10 per cent. dividend is paid.

British Algin Company, Limited.

This company was registered on the 18th ult. with a capital of £15,000, in £5 shares, to produce and supply algin, algulose or algic cellose, kalp substitute, and other useful products obtained from seaweed and marine plants, and generally to carry on the business of manufacturing chemists. The subscribers are:—

	Shares.
*T. J. Jones, 12, Prince's-street, Hanover-square, telegraph engineer	1
*J. G. Stapleton, 47, Lee-terrace, S.E., landowner	1
W. N. Tiddy, 12, Prince's-street, Hanover-square, electrician	1
F. B. Birt, 27, Leadenhall-street, shipbroker	1
E. H. Ellington, C.E., Palace-chambers, Westminster	1
H. Harker, 182, Upper Thames-street, merchant	1
*E. C. C. Stanford, Dalmuir, North Britain, chemical manufacturer	1

The number of directors is not to be less than three nor more than five; qualification, 70 shares or £350 stock, but this qualification will not be necessary for the subscribers denoted by an asterisk, who are appointed first directors. The company in general meeting will determine remuneration.

Tram-car and Vehicles Patent Fittings Company, Limited.

This company proposes to acquire the patent rights of George Reeves Smith, jun., for improvements in apparatus connected with tram-cars and other vehicles. It was registered on the 17th ult., with a capital of £10,000, in £5 shares, with the following as first subscribers:—

	Shares.
G. M. Duncan, 3, Trafalgar-terrace, Birmingham, merchant	1
G. Smith, Musgrave, Birchfield, Birmingham	1
H. H. Carlyle Sommerville, 20, Cannon-street, Birmingham, merchant	1
W. H. Hiscock, Redditch	1
W. J. Cosby, 21, Cannon-street, Birmingham, engineer	1
T. Whitehead, New-street, Birmingham, tailor	1
T. Whitehead, Harborne, Birmingham, clothier.	1

Registered without special articles.

Petroleum Association, Limited.

This association proposes to promote the importation into the United Kingdom of petroleum and other kindred products of the purest possible quality, and to provide for the uniform and accurate testing, sampling, analysis, and examination of petroleum, and for ascertaining and certifying the results thereof. It was registered on the 19th ult. as a company limited by guarantee to £1 each member. Under the 23rd section of the Companies' Act, 1867, the company is authorised by the Board of Trade to omit the word "limited" from its title. The subscribers are:—

A. Tremearne, South Sea House, produce broker, &c.
G. H. Trunck, Palmerston-buildings, merchant.
E. Dowling, 83, Cable-street, E., oil merchant.
A. Walton, 39, Borough High-street, oil merchant.
T. Hilton, 143, Great Suffolk-street, S.E., oil merchant.
J. A. Hess, 101, Leadenhall-street, merchant.
G. Mordaunt, 1A, St. Helen's-place, produce broker, &c.
Henry Webb, 6, Great St. Helens, produce broker, &c.

The management is vested in a council of not less than ten nor more than fifteen members.

Shanklin Esplanade Pier Company, Limited.

At Shanklin, Isle of Wight, this company proposes to construct a pier and all necessary approaches, &c. It was registered on the 22nd ult., with a capital of £12,000, in £5 shares. The subscribers are:—

	Shares.
F. Cooper, Shanklin	20
C. H. Moorman, Shanklin, lodging-house keeper.	20
J. Kent, Shanklin, brick manufacturer	20
W. H. Moorman, Shanklin, poulterer	10
C. Newman, Shanklin, grocer	2
J. Burley, Shanklin, outfitter	5
J. Hollings, Shanklin, general dealer	20

Registered without special articles.

Steel, Peech, and Seaman, Limited.

This company proposes to take over the business of steel file and saw manufacturer carried on at the Minerva Works, Eccleshall, Bierlow, Sheffield, with machinery and plant belonging thereto. It was registered on the 17th ult., with a capital of £6000, in £100 shares. The subscribers are:—

	Shares.
*Henry Steel, Sheffield	1
*William Peech, Roehampton, Surrey, steel manufacturer	1
*F. W. Seaman, Sheffield, steel manufacturer	1
Henry Steel, jun., Sheffield, steel manufacturer.	1
W. H. Peech, Sheffield, steel manufacturer	1
William Steel, Sheffield, steel manufacturer	1
Henry Peech, Sheffield, steel manufacturer	1

The subscribers denoted by an asterisk are the first directors; qualification, 10 shares.

Tilbury Dock, Ship and Engine Repairing Company, Limited.

This company was registered on the 19th ult., with a capital of £30,000, in £10 shares, of which 2500 are £10 per cent. preference shares, to carry on the business of ship repairers, shipbuilders, shipowners, and wharfingers in all branches at Tilbury Dock, or elsewhere in the United Kingdom. The company will acquire a lease of certain property described in an unregistered agreement between John Dunham Massey and William Gammon. The subscribers are:—

	Shares.
Wm. Gammon, 31, Nicholas-lane, railway traffic manager	1
Wm. Ball, 38, Hamilton-road, Brentford, clerk	1
C. H. A. Goodfellow, 2, Gresham-street, wine and spirit merchant	1
W. H. Goodfellow, 49, Rectory-square, Stepney, master mariner	1
R. J. Foster, 73, Charles-street, Stepney, patentee	1
C. H. Nicholson, 8, Laurence Pountney-hill, merchant	1
W. Sapte, jun., Sunderland-road, Forest-hill	1

The number of directors is not to be less than three nor more than five; qualification, 20 shares. The subscribers are to appoint the first; remuneration, £500 per annum.

Powell Aberbeeg Colliery Company, Limited.

This company was registered on the 22nd ult. with a capital of £100,000, in £10 shares, to trade as colliery proprietors, coke manufacturers, brickmakers, and fuel manufacturers. The subscribers are:—

	Shares.
D. T Alexander, Cardiff, auctioneer	1
W. Beddoe, Nelson, colliery proprietor	1
G. H. Daniel, M.E., Pontypool	1
G. C. James, Merthyr Tydvil, solicitor	1
J. Daniel, Aberychan, provision merchant	1
H. A. Huzzy, Newport, Mon., engineer	1
E. Phillips, Ebbw Vale, Mon., provision merchant	1
D. Lewis, Newport, colliery agent	1

The number of directors is not to be less than three nor more than seven; qualification, 50 shares; the subscribers are to appoint the first and act *ad interim*; the company in general meeting will determine remuneration.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Applications for Letters Patent.

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

18th December, 1885.

15,602. MINERS' SAFETY LAMPS, T. Marshall, London.
15,603. STRAP or BAND, A. F. Moriceau, London.
15,604. MINERAL OIL LAMPS, G. F. Redfern.—(*J. Fischer, Belgium.*)
15,605. CENTRIFUGAL MACHINES, G. F. Redfern.—(—*Rollet, France.*)
15,606. SEED DRILL, G. F. Redfern.—(*A. Legros, Belgium.*)
15,607. CORK STOPPERS and CORK, G. F. Redfern.—(*E. Bousquet, France.*)
15,608. MOVABLE PARTITIONS, DOORS, &c., D. and E. Glaister, London.
15,609. SECURING DOORS, D. and E. Glaister, London.

19th December, 1885.

15,610. WASHING CLOTHES, &c., H. W. Welch, London.
15,611. SHIPS' LAMP, T. S. Tongue, Handsworth.
15,612. KEYLESS WATCHES, C. H. Errington, London.
15,613. DOOR LOCKS, T. I. Gray, Blyth.
15,614. ARTIFICIAL FUEL, W. Menzies, Newcastle-on-Tyne.
15,615. LOOPS, BANDS, &c., for CURTAINS, T. Kendrick and W. Gibson, Birmingham.
15,616. TURNING GRINDSTONES, J. Staincliffe, Oakworth.
15,617. ELECTRICAL SWITCHES, H. B. and H. R. F. Bourne, London.
15,618. VALVE for WATER GAUGES, &c., W. Hartcliffe and W. H. Malkin, London.
15,619. CYLINDRICAL SUPPORTS for PHOTOGRAPHIC FILMS, F. Shew, London.
15,620. FEED-WATER HEATER, W. E. Walker, W. Peile, and W. Cook, Manchester.
15,621. PRESSURE GAUGE and CARTRIDGE RAMMER COMBINED, W. P. Jones, Birmingham.
15,622. METALLIC BEDSTEADS and COTS, J. and F. S. Turner, Dudley.
15,623. PERMANENT WAY of RAILWAYS, &c., B. Rathbone, Liverpool.
15,624. SHREDDING TOBACCO STALKS, J. McDonnell, Dublin.
15,625. SELF-ACTING BOLT for BOOKCASES, &c., F. H. Collins, Birmingham.
15,626. SCOOPS, W. Parnall, Bristol.
15,627. CAPTIVE KITE BALLOON, E. D. Archibald, Tunbridge Wells.
15,628. BRACES, &c., J. Cadbury and J. G. Rollason, Birmingham.
15,629. PRODUCING ARTIFICIAL LIGHT, W. J. Shirtcliff, Goole.
15,630. LOCKS, L. Platnauer, Birmingham.
15,631. RAISING and LOWERING WEIGHTS, J. Swalwell and J. Moore, London.
15,632. VEGETABLE BLUE DYE, W. Smith, London.
15,633. GIMP for ANGLERS, C. H. Cook, London.
15,634. OPENERS and SCUTCHERS, J. Hilton, Manchester.
15,635. PICTURE SCREW RINGS, &c., G. W. Herbert, Birmingham.
15,636. TELESCOPIC TABLES, J. Fraser, Glasgow.
15,637. BATCHING FIBROUS SUBSTANCES, &c., J. Menzies, Glasgow.
15,638. YARNS, R. G. Laidlaw, Glasgow.
15,639. STEAM BOILERS, C. A. Knight, London.
15,640. VALVES of STEAM HAMMERS, A. B. Baylis and R. Whysall, London.
15,641. STRIPPING BUTCHERS' STEELS, &c., W. Turner, London.
15,642. LIQUID METERS, H. E. Newton.—(*C. C. Worthington, United States.*)
15,643. DEVICE for SEWING MACHINES, R. Cragg, London.
15,644. CRANKS for MARINE ENGINES, &c., F. B. Salmon, Liverpool.
15,645. MUZZLES for DOGS, G. Baker, Birmingham.
15,646. CLEANING GRAIN, &c., J. W. Clinch and L. Greening, London.
15,647. SIGHT-FEED LUBRICATORS, J. T. Hailwood, Rochdale.
15,648. CLASPS for POCKET-BOOKS, &c., A. J. Boult.—(*H. Massouat, France.*)
15,649. HANGING CURTAINS, &c., C. H. Minchin, Middlesbrough.
15,650. LOCKING DEVICE, G. Ayers, London.
15,651. STANDARDS for SUPPORTING the SADDLES of VELOCIPEDES, J. Harrington, London.
15,652. OBTAINING ROTARY MOTION from ELECTRIC CURRENTS, E. O. Wehrle, London.
15,653. HYGIENIC TOOTH-BRUSH STAND, J. Needham and B. Lewis, London.
15,654. HYDRAULIC LIFTS, W. A. Gibson, London.
15,655. REGULATING the ADMISSION, &c., in STEAM ENGINES, A. P. S. Jones, London.
15,656. HYDRAULIC ENGINES, H. Moore and I. D. Pollard, London.
15,657. ROOF LAMPS for CABS, &c., A. C. Jones and J. Dore, London.
15,658. ELECTRICAL SWITCHES, B. M. Drake and J. M. Gorham, London.
15,659. HAND-PRINTING, &c., MACHINES, J. L. Sampson, London.
15,660. RAILWAY CARRIAGE and other SEATS, W. McLaren, London.
15,661. HAT EXPANDERS, J. Calverley and J. G. Whitehead, London.
15,662. GAS BURNERS, W. R. Lake.—(*A. Wasserman, United States.*)
15,663. PENCIL-CASES, &c., G. F. Redfern.—(*R. Spear, Bavaria.*)
15,664. SEPARATING SUBSTANCES from PHOSPHATE of LIME, T. R. Shillito.—(*E. Hänisch and M. Schroeder, Prussia.*)

21st December, 1885.

15,665. TOOL-REST for HAND-TURNING LATHES, J. Murgatroyd, Manchester.
15,666. CONTROLLING the DRAUGHT of the FURNACES of FIRING BOILERS, W. Hutchinson and C. Thompson, Sunderland.
15,667. LEVER PADLOCKS, W. H. St. Aubin, Bloxwich.
15,668. PERAMBULATORS, &c., C. A. Marriott, Manchester.
15,669. FANCY COTTON YARNS, Dickinson Bros. and Co., Halifax.
15,670. REMOVING DEPOSIT from STEAM BOILERS, W. W. Kay, Aston.
15,671. FASTENING the ENDS of DRIVING BANDS, T. H. Smethurst, Manchester.
15,672. CAPLIN, E. Townsend, Oldbury.
15,673. ENGLISH STANDARD WEIGHTS, W. Parnall, Bristol.
15,674. SECONDARY BATTERIES or ACCUMULATORS, P. Higgs, London.
15,675. CARRIAGE TRACES or PULLS, S. Ogden and C. Peters, Manchester.
15,676. BARTON PATENT PORCELAIN BURNER, W. H. and J. Wathen, Birmingham.
15,677. REVOLVING COUPLING JOINTS for WATER, &c., PIPES, R. Barker, Whitehaven.
15,678. CHEMICAL or ANALYTICAL BALANCES, W. E. Heys.—(*E. Becker, United States.*)
15,679. WOVEN DRIVING BANDS or BELTS, S. Ogden, Manchester.
15,680. LAMPS, W. Defries, London.
15,681. FORMING the HEADS and FORKS of BICYCLES, B. Kelsey, Birmingham.
15,682. HOLDING DOWN the SPINDLES of SPINNING MACHINERY, R. N. Cottrill, Manchester.
15,683. PRESSER ROLLERS of SIZING MACHINES, P. Brimelow, Halifax.
15,684. LEAD GLAZING, G. Sowerby, Newcastle-upon-Tyne
15,685. PATTERN-MAKERS' CUP DOWELS, J. and T. E. Jennens, Birmingham.
15,686. FURNACES for BURNING LIQUID FUEL, W. M. Fraser, Glasgow.
15,687. HOT-PLATE BARS for GAS COOKING RANGES, T. Fletcher, Manchester.
15,688. ROLLERS for ROLLING CLOTH, &c., R. Longdon, Manchester.
15,689. CONCRETE MIXING MACHINES, H. Stockman, Hampton.
15,690. PREPARING WARPS for WEAVING PATTERNS, R. G. Neill, Glasgow.
15,691. PHOTOGRAPHY, J. Swain, London.
15,692. ROTARY STEAM ENGINES, J. Wakefield, London.
15,693. CIGARS, CHEEROOTS, &c., F. Taylor, Liverpool.
15,694. SAFETY BLASTING CARTRIDGES and DETONATORS, The Patent Oxonite Company and R. Punshon, London.
15,695. PROJECTILES for OPERATIONS of WAR, S. H. Emmens, London.
15,696. SMOKELESS GUNPOWDERS, S. H. Emmens, London.
15,697. EXPLOSIVE SUBSTANCES, S. H. Emmens, London.
15,698. PACKING for PISTON-RODS, &c., A. A. Rickaby, London.
15,699. APPARATUS for FIRE-ESCAPES, &c., G. Edwards, Thornton Heath.
15,700. RAILWAY CARRIAGE, &c., WINDOWS, J. Young.—(*W. S. Gibson, Netherlands.*)
15,701. INSULATION of ELECTRIC AERIAL LINE WIRES, A. E. Gilbert, Glasgow.
15,702. DANDY ROLL CARRIAGES, T. A. Marshall, London.
15,703. FASTENINGS for RAILWAY, &c., WINDOWS, A. Boots, London.
15,704. LOCKS, H. J. Haddan.—(*F. W. Poestges, Germany.*)
15,705. COATING PAPER, &c., with WATERPROOF MATERIAL, C. E. Mey, London.
15,706. WATER-GAS APPARATUS for DISTILLATION of FRESH FUEL, E. Blass, London.
15,707. SLIDE VALVES and COCKS, E. Blass, London.
15,708. CARRIAGES, G. F. Redfern.—(*F. Tharaud, France.*)
15,709. CONTINUOUS POWER PRESSES, A. Attwood, London.
15,710. GOVERNORS for GAS, &c., ENGINES, J. H. Johnson.—(*E. Delamare-Deboutteville and L. Malandin, France.*)
15,711. NAVIGABLE SHIPS for CARRYING LIQUIDS, H. F. Swan, London.
15,712. GUN MOUNTINGS, J. Vavasseur, London.
15,713. SUBSIDENCE APPARATUS, S. H. Johnson and C. C. Hutchinson, London.
15,714. GALVANIC BATTERIES, A. R. Upward and C. Pridham, London.
15,715. DRIVING GEAR for TRICYCLES, &c., F. G. M. Stoney and G. Turton, London.
15,716. COLOURING MATTERS, C. Rudolph and O. Gürke, London.
15,717. TEXTILE FABRIC, W. R. Lake.—(*F. E. J. Dubar, France.*)
15,718. BURGLAR or other ALARM, J. C. Fell.—(*A. Buckingham, Belgium.*)
15,719. SECURING the CONTENTS of BOTTLES, &c., H. Graepel, London.
15,720. PERMITTING a STREAM of WATER to PASS THROUGH the CLOSED CRANK CHAMBERS of QUICK-RUNNING ENGINES, P. W. Willans, Thames Ditton.—*3rd November*, 1885.
15,721. CHOCOLATE, A. F. Besnier and F. L. Corbière, London.
15,722. CARTRIDGE CASES, E. Martin, London.
15,723. PUNCHING and DRILLING MACHINES, C. F. Findlay, London.
15,724. UMBRELLAS and PARASOLS, O. Jones, London.
15,725. AIR and WATER-TIGHT SEAM, G. J. Tagg, London.

22nd December, 1885.

15,726. ORGANS, E. H. Suggate, London.
15,727. OPERATING the BOX TAPPITS employed in BOX LOOMS, H. R. Middlemost, C. H. Crowther, and R. Ramsden, Halifax.
15,728. MIRROR READING STAND, &c., D. Freeman, Birmingham.
15,729. CASTORS, S. Holgate and J. Tayler, Accrington.
15,730. ENVELOPES for COVERING BOTTLES, W. Somerville, Glasgow.
15,731. LOCKS for RAILWAY CARRIAGE, &c., DOORS, J Maxwell, Glasgow.
15,732. BLAST FURNACES, H. McVicar, Glasgow.
15,733. CEMENTING DESIGNS on GLASS, &c., W. Parrott Harman, London.
15,734. SCREW PROPELLER, H. J. Allison.—(*E. H. Hall, United States.*)
17,735. CONNECTING SOFT METAL PIPES, A. G. Browning, Llanelly.
15,736. ILLUSTRATED BUTTON, B. R. H. Church and J. Richardson, Birmingham.
15,737. GAS ENGINES, J. E. Rogers, Tipton.
15,738. HOUSE TRAPS, W. M. Egglestone, Stanhope.
15,739. LATRINES, M. J. Adams, York.
15,740. UMBRELLAS, C. Howell, Glasgow.
15,741. LOCKS, J. Buchanan, Glasgow.
15,742. COUPLING and UNCOUPLING RAILWAY CARRIAGES and WAGONS, R. Lansdale, Halewood.
15,743. GLASS, H. Standen, London.
15,744. BANDAGE for WOMEN, H. Sommerfeld.—(*S. Immerkamp, Germany.*)
17,745. EXTINGUISHING CANDLES, J. Schöpfer, London.
15,746. CRIMPING the ENDS of PAPER CARTRIDGE SHELLS, A. J. Boult.—(*H. T. Hazard, United States.*)
15,747. PHOTOGRAPHIC SHUTTER, C. D. Durnford, London.
15,748. CABLE RAILWAYS, D. J. Miller, London.
15,749. HANDLES of CRICKET BATS, F. H. Ayres, London.
15,750. LEG-GUARDS, F. H. Ayres, London.
15,751. CHARGING CEMENT KILNS, W. Joy, London.
15,752. ANTI-CORROSIVE ENAMEL PAINT, P. Lawson, Glasgow.
15,753. VENTILATING RAILWAY TUNNELS, C. Wells, London.
15,754. FLOATING ANCHOR, C. Wells, London.
15,755. COMMUNICATING from SHIP to SHORE, &c., C. Wells, London.
15,756. NAVIGABLE BALLOON, C. Wells, London.
15,757. STOPPERING BOTTLES and JARS, C. Wells, London.
15,758. STEERING BALLOONS, C. Wells, London.
15,759. COMPRESSED FUEL, &c., S. W. Allen and G. Breffit, London.
15,760. GANISTER CEMENT, J. Longden, Sheffield.
15,761. DYEING FELT, &c., H. J. Haddan.—(*J. F. Meyer and G. Klinkenberg, Germany.*)
15,762. OBTAINING SUPERHEATED STEAM at CONSTANT TEMPERATURE, A. G. Martin, London.—*5th August*, 1885.
15,763. VELOCIPEDES, J. Harrington, London.
15,764. GAS MOTOR ENGINES, C. Eyre, London.
15,765. COMBINING MATTRESSES with BEDSTEADS, G. H. Slack, London.
15,766. OINTMENT, R. E. R. James, London.
15,767. REPEATING FIRE-ARMS, A. J. Boult.—(*C. H. Palmer, United States.*)
15,768. MAKING GAS, A. M. Clark.—(*J. S. Leng, United States.*)
15,769. SIGNALLING by HELIOGRAPH, R. Paulson, Mansfield.
15,770. DIRECT-ACTING ENGINES, H. E. Newton.—(*C. C. Worthington, United States.*)
15,771. PACKING RODS, H. E. Newton.—(*C. C. Worthington, United States.*)
15,772. GAS MOTOR ENGINES, H. Williams, Manchester.
15,773. CABLE RAILWAYS, D. J. Miller, London.
15,774. EXTINGUISHING FIRES in MILLS, C. J. Hexamer, London.
15,775. COLOURING MATTERS, H. H. Lake.—(*The Schoellkopf Aniline and Chemical Company, United States.*)
15,776. STEAM VENTILATING APPARATUS, C. McWhirter, London.

15,777. MUZZLES for DOGS, &c., H. R. Marshall, London.
15,778. METAL STRAPS, H. Frank and A. F. Hochstadte, London.
15,779. SEPARATING DUST from AIR, H. H. Lake.—(*C. H. Morgan, United States.*)
15,780. UTILISING FUEL, H. H. Lake.—(*H. K. Flagler, United States.*)
15,781. COLOURING MATTERS, H. H. Lake. — (*The Schoellkopf Aniline and Chemical Company, U.S.*)

23rd December, 1885.

15,782. FOLDING TABLE, H. Riddiough and T. Riddiough, Crosshills.
15,783. SEWING MACHINES, W. Pennington, Belfast.
15,784. TWO-WHEELED VEHICLES, O. F. Windover, Huntingdon.
15,785. VALVE GEARING, J. Thom, Barrow-in-Furness.
15,786. POWER BOTTLING MACHINE, T. H. Hayes, Manchester.
15,787. PARCEL CARRIER, J. Cadbury and J. G. Rollason, Birmingham.
15,788. BEDSTEADS, G. Woods and E. Woods, Liverpool.
15,789. CONSUMING GASES, T. Clegg, Manchester.
15,790. INDEPENDENT WHEEL ATTACHMENT, J. Hodgkins, Warwick.
15 791. PRINTING upon TISSUES, &c., S. Stansfield and E. J. Homan, Manchester.
15,792. COMBINED PINCERS and STILETTO TOOL, J. Johnson, Birmingham.
15,793. ROCKING BARS for FURNACES, D. Jones and J. Brunt, Burton-on-Trent.
15,794. TELEGRAPH POSTS, A. Eadie and J. Tannahill, Glasgow.
15,795. STEAM BOILERS, J. Howden, Glasgow.
15,796. DRIVING MACHINERY, R. Rogers, London.
15,797. ACCORDEONS, &c., T. S. Beswick, Liverpool.
15,798. SHIPS' RUDDERS, J. M. H. Taylor and L. Benjamin, Birkenhead.
15,799. MECHANICAL GAME BOARD, I. Greenbury, Edinburgh.
15,800. DRIVING the SHOES of THRASHING MACHINES, A. Evans, Glasgow.
15,801. LUBRICATORS, J. D. Noble, Glasgow.
15,802. BOOT or SHOE WARMER, R. G. Owen, London.
15,803. MINERAL ILLUMINATING OIL, S. Banner, Liverpool.
15,804. NECKTIES, &c., W. P. Thompson.—(*R. B. Halliwell, United States.*)
15,805. SHOULDER REST for the VIOLIN, F. Upton, London.
15,806. GUN LAMP, &c., J. N. Purkis, Upper Walmer.
15,807. FACILITATING the TEACHING of LETTERS, &c., L. A. Groth.—(*C. D. H. Thureau, France.*)
15,808. SELF-ACTING LIFTING APPARATUS, R. N. Boyd, London.
15,809. TREATMENT of FLAX, &c., T. R. Shillito.—(*R. Baur, Germany.*)
15,810. FASTENINGS for TRUNKS, &c., J. Marston and G. Cooch, London.
15,311. CLEANSING SMOKE FLUES, &c., W. Doehring, London.
15,812. STEAM GENERATORS, J. W. Restler, London
15,813. TREATING FLUX SKIMMINGS, E. G. Colton.—(*A. F. Wendt, New York.*)
15,814. COLLECTING FLOAT, &c., GOLD, M. Vosenmayer, London.
15,815. APPARATUS for RAISING WEIGHTS, E. P. Wright, London.
15,816. KINDLING FIRES, R. H. Cooke and J. P. Thorn, London.
15,817. TRANSMITTING ARTICULATE SPEECH, A. F. St. George, London.
15,818. MECHANISM of VELOCIPEDES, W. J. Lloyd and W. Priest, London.
15,819. TRAMWAY POINTS, F. H. Lloyd and T. Arnall, London.
15,820. DOOR SHIELD or FINGER-PLATE, E. E. Pither, London.
15,821. REGULATING WATER TAPS, A. J. Boult.—(*E. Clausolles, Spain.*)
15,822. ILLUMINATING LIGHTHOUSES, J. R. Wigham, London.
15,823. INDIA-RUBBER TIRES, W. H. Bates and H. Faulkner, London.
15,824. TYPE-WRITING MACHINE, J. Lister, London.
15,825. COMBINED READING, WRITING, &c., CHAIR, J. Sothcott, London.
15,826. WINNOWING MACHINES, W. Seck, London.
15,827. COAL-SCUTTLES, W. Edwards, London.
15,828. DRYING BONE-BLACK, S. M. Lillie, Philadelphia.

24th December, 1885.

15,829. GAS MOTOR ENGINES, W. Bowden, Manchester.
15,830. TEACHING DRAWING, J. H. Russell, Liverpool.
15,831. STEAM PRESS, A. J. Gimson, Leicester.
15,832. BOILERS, G. Pickersgill, Halifax.
15,833. WOOL-WASHING MACHINE, W. Robertshaw and E. Cockcroft, Bradford.
15,834. ACTUATING DROP-BOXES in LOOMS, D. and W. A. Crabtree, Bradford.
15,835. TURNING STEEL INGOTS or SLABS, &c., J. Spencer and C. Robertson, Coatbridge.
15,836. DISTILLING AMMONIA, N. M. Henderson, Broxburn.
15,837. ELEVATORS, W. H. Baxter, Halifax.
15,838. MOTIVE POWER ENGINES, &c., J. Blake, Manchester.
15,839. DIGGING and PULVERISING LAND, J. Brown, North Murie.
15,840. AUTOMATICALLY DELIVERING GOODS, J. R. M'Neil, London.
15,841. SUPPLYING OIL to LAMPS, F. Bishop, Leighton Buzzard.
15,842. PROTECTING HEARTHRUGS, &c., from DIRT, E. Hand, Ben Rhydding.
15,843. REGULATING the DURATION of an AUDIBLE SIGNAL on the RISE or FALL of TEMPERATURE, C. Lindley and F. J. Mudford, London.
15,844. FASTENER for GLOVES, &c., E. Fisher, London.
15,845. GAS MOTOR ENGINES, H. N. Bickerton, London.
15,846. LETTER SHEET, A. J. Boult.—(*A. C. Campbell, Canada.*)
15,847. CASEMENT WINDOW STAY, D. Howell, London.
15,848. HORSESHOES, R. S. Moncaster, London.
15,849. SMOKING PIPES, W. B. Haas, London.
15,850. ATTACHMENTS for BRACES, F. Cooper, London.
15,851. HEATING AIR, H. Podger and G. Bryant, London.
15,852. REGENERATIVE GAS LAMPS, S., S., and J. Chandler, London.
15,853. REELS or SPOOLS, J. Hickisson, London.
15,854. BOOT SEWING MACHINERY, H. E. Newton.—(*T. Cowburn, Austria,*)
15,855. CORN SCREENS, D. Hearn, London.
15,856. SLATE or GLASS ROOFING, J. S. and W. Thompson, London.
15,857. METALLIC PACKING, T. Andrews and T. Grant, Liverpool.
15,858. BAKING, &c., APPARATUS, H. Fowler, London.
15,859. CAB DOORS, F. and C. Forder, London.
15,860. JOINTS of STONEWARE PIPES, H. L. Doulton, London.
15,861. BOTTLES, J. Deeks, London.
15,862. MOUNTING AXLE BEARINGS, S. Pitt.—(*J. Strachan and F. Watkins, India.*)
15,863. BOBBINS and TUBES, S. Wilson, Dublin.
15,864. PURIFYING WATER, &c., F. R. Conder, London.
15,865. DUPLEX FURNACES, W. R. Jones, London.
15,866. FASTENING for STAYS and CORSETS, J. W. Russell, London.
15,867. SECURING NUTS UPON SCREW BOLTS, P. Büsche. —(*R. Neuschäfer, Germany.*)
15,868. CLOSET-PAN DISINFECTANT, F. Candy and N. Frere, London.
15,869. PRIMARY BATTERY, V. L. A. Blumberg, London.
15,870. HOT AIR HEATING, &c., STOVE, W. J. Lea, London.
15,871. WASTE COTTON YARNS, E. Edwards.—(*T. G. Meili, Germany.*)
15,872. CRICKET, TENNIS, &c., BATS, J. Davenport, London.
15,873. INTERNALLY-HEATED BOILERS, F. Bruggemans and L. Donkers, London.
15,874. GAS ENGINES, S. Wilcox, London.
15,875. GAS ENGINES, S. Wilcox, London.
15,876. GAS ENGINES, S. Wilcox, London.
15,877. DRESSING, POLISHING, &c., STONE, J. Dejaiffe, London.
15,878. MULTIPLE PUNCHING, &c., MACHINE, M. and C. Berger, London.
15,879. CUTTING BLANKS for ANIMAL SHOE-NAILS, G. Macaulay-Cruikshank. — (*J. O. J. and A. B. J. Kollén, Sweden.*)
15,880. TROUGH WATER-CLOSETS, &c., E. R. Palmer, London.
15,881. SHOES for HORSES, G. C. Hill, Glasgow.
15,882. RECEPTACLES for PRESERVING GRAIN, C. Rabitz, London.
15,883. LAUNCHING TORPEDOES, A. F. Yarrow, London.
15,884. SUPPLYING AIR to STEAM BOILERS for TORPEDO VESSELS, A. F. Yarrow, London.
15,885. SPEED-REGULATING and CONTROLLING APPARATUS for CRANES, &c., J. H. Johnson.—(*E. V. V. de P. Desdouits, France.*)
15,886. ADVERTISING CONTRIVANCE, J. F. Peasley, London.
15,887. ENABLING OBJECTS UNDER WATER to be PHOTOGRAPHED, R. R. Armstrong and M. Constable, London.
15,888. EXPANSION GEAR, H. Kuhne.—(*R. Proell, Germany.*)
15,889. ALTERING the THROW of CRANKS, S. C. Maguire, London.
15,890. RAILWAY TICKETS, &c., W. F. B Massey-Mainwaring, London.
15,891. GUN LOCK, W. H. Beck.—(*A. Francotte, Belgium.*)
15,892. SOLITAIRES, &c., R. R. Breidenbach and G. H. Wilson, London.
15,893. CLOSING, &c., CURTAINS, R. B. Breidenbach and G. H. Wilson, London.
15,894. PHOTOGRAPHIC CAMERA for JUGGLING, L. Millinet, London.
15,895. PURIFYING LIQUIDS, C. D. Abel.—(*M. M. Rotten, Germany.*)
15,896. SEPARATING LIQUIDS of DIFFERENT DENSITIES, E. R. Prentice, London.
15,897. REVIVIFYING CHARCOAL, M. P. W. Boulton, B. E. R. Newlands, and E. Perrett, London.
15,898. FURNACES, J. T. Griffin.—(*J. W. Hatch, United States.*)
15,899. MACHINE for CUTTING, &c., WOOD, F. Kingston, London.

28th December, 1885.

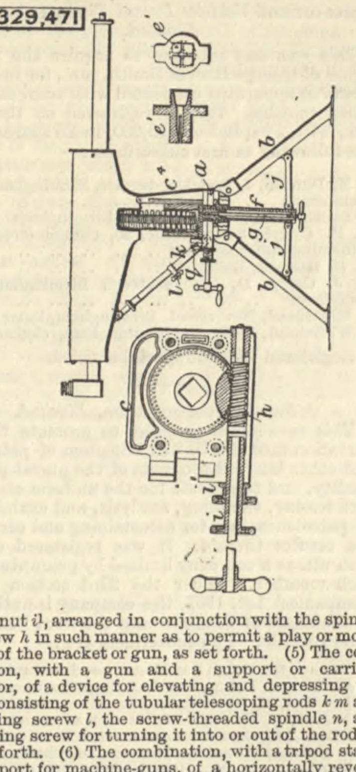
15,900. SELF-CLOSING DOORS, F. Bapty.—(*W. H. Campbell, Russia.*)
15,901. MULTIPLEX COATED SHEETS, J. R. Turnock, Loughor.
15,902. ROLLING DOUGH, J. Vicars, sen., and T. and J. Vicars, jun., Liverpool.
15,903. GAS LAMPS, J. Roots, Tottenham.
15,904. GAS LAMPS, J. Roots, Tottenham.
15,905. CURLING HATS, W. H. Blackwell and J. Ridyard, Ashton-under-Lyne.
15,906. RENDERING FABRICS WATERPROOF, T. F. Wiley, Bradford.
15,907. ROULETTE for FURNITURE, H. Musse and C. Cattoen, Marseilles.
15,908. SEWING MACHINES, W. E. Heys.—(*B. Rudolph, Prussia.*)
15,909. STEAM ENGINES, A. B. Wilson, Belfast.
15,910. PLACING PULLEY BELTS, W. Brierley and J. Haughton, Rochdale.
15,911. TOWELLINGS, E. and G. W. Wilson and J. Fell, Manchester.
15,912. BICYCLES, &c., W. Andrews, Birmingham.
15,913. WIRE BAND or CORD, E. Atkins, Birmingham.
15,914. FASTENERS for GLOVES, &c., S. R. Barnett, Birmingham.
15,915. NOSE BAGS for HORSES, &c., C. C. Brown and E. French, Birmingham.
15,916. EXTRACTORS for SMALL ARMS, J. and J. G. Thomas, Birmingham.
15,917. APPARATUS for COOKING by GAS, &c., J. Balbirnie, Sheffield.
15,918. LIFT AQUEDUCT with SELF-ACTING LOCK, F. Bolton, Manchester.
15,919. METAL BOXES for HOLDING WAX, &c., MATCHES, S. Timings, Birmingham.
15,920. GAS MOTOR ENGINES, C. W. King, Southport.
15,921. DRYING of MOULDS for CAST IRON PIPES and COLUMNS, R. and J. Buchanan, Dumbarton.
15,922. COLLAR STUD, J. G. Campbell, Paisley.
15,923. PREVENTING ACCIDENTS in MINE SHAFTS, W. Watson, London.
15,924. FLEXIBLE WASHER for AERATED WATER BOTTLES, T. Hill, London.
15,925. KNITTING MACHINES, W. and H. Paulson, London.
15,926. ELECTRICAL and MECHANICAL TOYS, J. H. Galloway and W. Banks, London.
15,927 "BACK-PRESSURE" VALVES, T. Witter, London.
15,928. TUYERES, G. Macaulay-Cruikshank.—(*A. and G. Roth, Germany.*)
15,929. PIANOFORTE ACTIONS, W. H. Squire, London.
15,930. GOVERNORS for MARINE ENGINES, I. Henderson, London.
15,931. VACUUM BLOWER for STOVES, R. J. White, London.
15,932. DRESS IMPROVERS for LADIES, J. Badcock, London.
15,933. LINIMENT, R. Clayton, London.
15,934. SYPHON BOTTLE for AERATED BEVERAGES, F. J. B. Raken, London.
15,935. TUBES for STEAM BOILERS, &c., A. Montupet, London.
15,936. EQUALISING the POWER GIVEN OFF by ENGINES, H. W. Wimshurst, Anerley.
15,937. PREPARING TIMBER for FLOORING, &c., H. Ker, Annan, N.B.
15,938. SELF-FITTING JOINT PIN, A. Gautier and S. Pozzy, London.
15,939. BANDS for GRINDING or POLISHING, F. Cooper, T. P. Evans, and J. C. W. Stanley, London.
15,940. PREPARING WOOD, &c., for PRINTING, A. J. Boult.—(*H. Bogaerts, Holland.*)
15,941. TRAMWAY LOCOMOTIVES, &c., F. J. Burrell, London.
15,942. HANSOM CABS, E. J. Atkinson, London.
15,943. CREAM for TOILET PURPOSES, P. Jensen.—(*S. Winkler, Hungary.*)
15,944. CUTTING PLASTIC SUBSTANCES, J. G. Baker, London.
15,945. PEN EJECTOR, W. E. Gedge.—(*P. O'Kelly and Co., France.*)
15,946. RAKES. J. A. Carlés, London.
15,947. FULLER'S EARTH, F. Candy, London.
15,948. TREATING CLAY, F. Candy, London.
15,949. LADIES' CORSETS, R. C. Gardner.—(*A. Rammoser, Germany.*)
15,950. GAS BURNERS, J. Lewis, London.

SELECTED AMERICAN PATENTS.

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

329,471. SUPPORTS FOR MACHINE-GUNS, *Hiram S. Maxim, London, county of Middlesex, England.—Filed March 14th*, 1885.

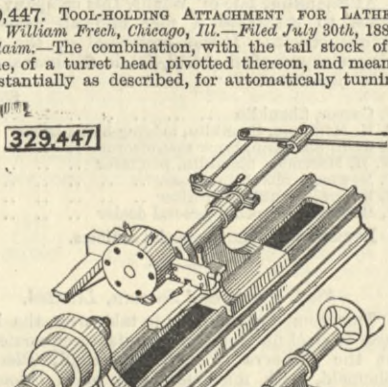
Claim.—(1) The combination, with a magazine or machine-gun, of a carriage or support consisting of the casting or piece *a*, the pivotted tripod legs *b*, the tube *f*, entering the casting *a*, and links *j*, pivotally connected with the tube and with the legs, as and for the purpose specified. (2) In the gun support or carriage, the combination, with the suitably supported casting *a*, of the bracket *c*, pivotted to said casting by a pivot which is secured to the casting by an expanding stud e^1, and screw rod *g*, having a wedge-like end, which enters said stud, substantially as set forth. (3) The combination, with the suitably supported casting *a*, of the worm wheel *d*, fixed to said casting, the gun-supporting bracket *c*, pivotted to the casting concentrically with said worm wheel, and the endless screw or worm mounted on said bracket and engaging with the fixed worm wheel, substantially as described. (4) The combination, with a stand or support, of a bracket carrying a gun and pivotted thereto, a worm wheel *d*, fixed to the stand or support, a screw *h*, for turning the same, and a screw-threaded bush *i*, and



check nut i^1, arranged in conjunction with the spindle of screw *h* in such manner as to permit a play or movement of the bracket or gun, as set forth. (5) The combination, with a gun and a support or carriage therefor, of a device for elevating and depressing the gun, consisting of the tubular telescoping rods *k m* and clamping screw *l*, the screw-threaded spindle *n*, and adjusting screw for turning it into or out of the rod *m*, as set forth. (6) The combination, with a tripod stand or support for machine-guns, of a horizontally revolving gun-supporting bracket mounted upon said stand or support and provided with ribs c^4, and a suitably mounted clamping screw *q*, arranged upon the bracket for holding in place a cartridge receptacle as set forth. (7) The combination, with a tripod stand or support, of a revolving bracket carrying a gun and mounted on said stand and shields or plates *s*, inserted in suitable grooves in the bracket to form a defensive armour or covering, as herein described.

329,447. TOOL-HOLDING ATTACHMENT FOR LATHES, *William Frech, Chicago, Ill.—Filed July 30th*, 1884.

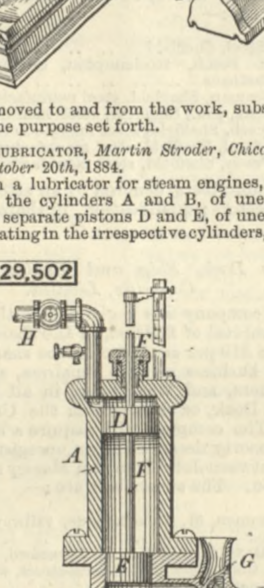
Claim.—The combination, with the tail stock of a lathe, of a turret head pivotted thereon, and means, substantially as described, for automatically turning



it as it is moved to and from the work, substantially as and for the purpose set forth.

329,502. LUBRICATOR, *Martin Stroder, Chicago, Ill.—Filed October 20th*, 1884.

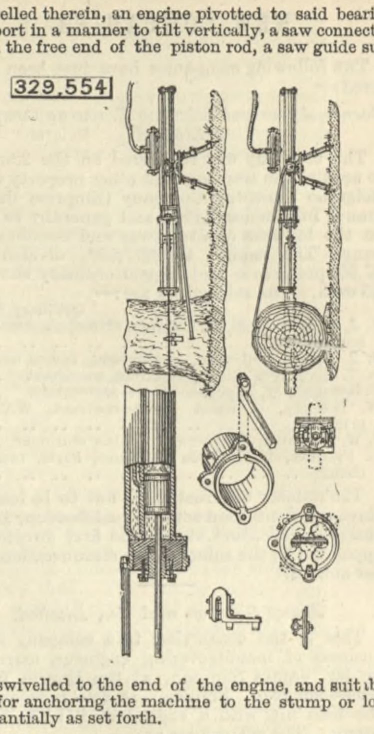
Claim.—In a lubricator for steam engines, the combination of the cylinders A and B, of unequal diameters, two separate pistons D and E, of unequal diameters, operating in the irrespective cylinders, connect-



ing piston-rod F, protruding at its upper end through the upper end of such cylinder A, ducts H and I, communicating with their respective cylinders A and B, and oil duct G, provided with valve J, substantially as and for the purpose specified.

329,554. TREE AND LOG SAWING MACHINE, *William E. Hill, Kalamazoo, Mich.—Filed February 20th*, 1885.

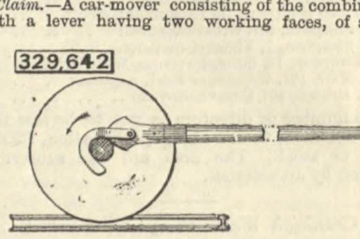
Claim.—(1) A tree-felling machine consisting of the engine, a swivelled support therefor, a saw secured to the free end of the piston rod, and a guide frame swivelled to the end of the engine, substantially as set forth. (2) A combined tree-felling and log-sawing machine consisting of the engine, a support therefor, said engine pivotted to said support in a manner to tilt vertically, and the support swivelled to allow the engine to swing laterally, a saw secured to the free end of the piston rod, and a saw guide frame swivelled to the end of the engine, substantially as set forth. (3) The combination of a base plate, a bearing support swivelled therein, an engine pivotted to said bearing support in a manner to tilt vertically, a saw connected with the free end of the piston rod, a saw guide sup-



port swivelled to the end of the engine, and suitable rods for anchoring the machine to the stump or log, substantially as set forth.

329,642. CAR-MOVER, *Clarence V. Greenamyer, Western. Nebr.—Filed April 23rd*, 1885.

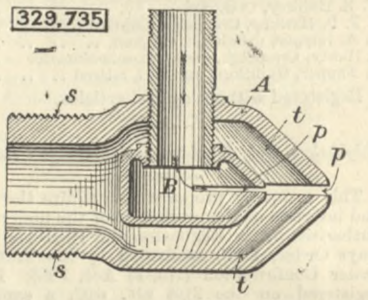
Claim.—A car-mover consisting of the combination, with a lever having two working faces, of a hook



pivotted to the lever at a point excentric to the working or gripping faces, substantially as described.

329,735. FEEDING AIR TO FURNACES, *Edgar A. Hanna, Chicago, Ill.—Filed September 20th*, 1884.

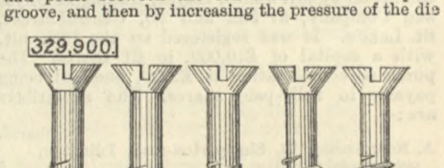
Claim.—A device for increasing combustion and preventing smoke in furnaces, comprising a shell A, cast in two parts *t* and t^1, each semicircular, or nearly so, at one extremity, and secured together, and having an outlet *p* between them, the part *t* having an opening in its body, a tubular extension *s*, projecting from the end of the shell A, a shell B, corresponding in



shape with the shell A, and supported within the said shell A, and provided with an outlet p^1, coinciding with the outlet *p*, and with an opening in its body coinciding with the said opening in the body of the shell A, the whole being constructed and arranged to operate substantially as described.

329,900. METHOD OF MAKING ROLLED WOOD-SCREWS, *Hayward A. Harvey, Orange, N.J.—Filed January 10th*, 1885.

Claim.—The herein-described method of forming the threads upon the body and point of gimlet-pointed screws by means of a die or dies provided with parallel inclined ribs acting to form the convolutions of the thread upon the point and simultaneously, to wit: first, impressing a shallow V-shaped spiral groove upon the body and conical point of the blank, and thereby throwing out from the blank two parallel ridges of metal extending spirally around the body and point between the convolutions of the spiral groove, and then by increasing the pressure of the die



upon the blank, deepening the spiral groove and enlarging the diameter of the parallel ridges and folding them together by transverse compression, then by subjecting the blank to the action of a rolling die, the inclined parallel ribs of which are truncated, transforming the V-shaped spiral groove into a flat-bottomed spiral groove, displacing the metal from the bases of the convolutions of the thread and causing it to flow outward from the body of the blank, and thus closely uniting the apices of the parallel ridges, and thereby forming the sharp-edged thread of the finished screw.