WHY THE COMPOUND ENGINE IS ECONOMICAL.

We publish this week a very remarkable paper by Mr. Isherwood, which we copy from the last number of the *Journal of the Franklin Institute*. This paper bears strongly on the much vexed question, What is the most economical ratio of expansion? and we direct the attention of our readers to it as a document deserving their most careful consideration. Mr. Isherwood gives in it what seems to us to be a perfectly rational, albeit novel, explanation of the reason why a compound engine ought to be more economical than a simple engine; and this explanation, we may add, has nothing whatever to do with one repeatedly put forward, notwithstanding that its fallacy has been over and over again demonstrated—namely, the "heat trap" theory. That is to say, the assumption that the low-pressure cylinder prevents a large change of temperature causing condensation in the high-pressure cylinder. Mr. Isherwood's paper is something much more than a translation of the report made by a committee of German engineers. In 1878 the Industrial Society of Mulhouse offered a medal of honour for the first compound engine built in Alsace that would give a French horse-power—32,544 foot-pounds per minute—for not more than 9 kilogrammes, or about 19·84 lb., of steam used per hour—equivalent to about 17·44 lb. per English horse-power. The action of the Industrial Society is highly to be commended, and it is to be regretted that no similar stimulus to improvement is ever offered in this country. In 1879 the challenge was accepted by Messrs. Weyher and Richemonde under circumstances which Mr. Isherwood fully sets forth. The result of the trial was that their engine won the prize. Three distinct experiments were made with steam expanded 6·25 times, the consumption of feed-water being at the rate of 17·1 lb. per English horse-power per hour. One experiment was made with steam expanded 9·64 times, the weight of feed-water used being 16·93 lb. Thus no practical advantage whatever was gained from the higher ratio of expansion. As the experiment was intended to settle the value of expansion *per se* without introducing complications in the way of alterations of pressure, the initial pressure was as nearly as possible the same in all four experiments, namely, about 92 lb. per square inch. For details we must refer our readers to the comprehensive table which will be found on page 266.

This investigation supplies matter for consideration by those who still maintain that the—to them—otherwise unaccountable economy of the compound engine is due to the protection afforded by the large cylinder to the small one, and the consequent prevention of condensation in the latter. It is a curious aspect of this controversy that no one has ever yet given or attempted to give any direct proof that condensation is reduced; while, on the other hand, we cannot call to mind particulars of a single experiment in which the condensation in the high-pressure cylinder of a compound engine has not been enormous. In the case under consideration it will be seen that when the small range of expansion—6·25 times—was employed, no less than about one-fourth of all the steam admitted to the engine was condensed in the high-pressure cylinder during the time the steam port was open. With the larger measure of expansion, only 57 per cent. remained uncondensed. To put this in a more telling way, we may say that, in the former case, out of every 100 lb. of steam that entered the engine, 25 lb. were condensed, while in the latter case no less than 43 lb. out of the hundred were condensed. The influence of the second cylinder in reducing condensation seems to have been *nil*. It remains to be proved indeed that the condensation in any jacketted non-compound cylinder, in which the steam is expanded six and a-quarter times, ever reaches 25 per cent. We do not say that condensation to this extent does not take place, but only that we have not seen any proof that it does. We do not pretend to explain the fact, but all available evidence goes to show that the quantity of steam condensed in the compound engine is greater than the quantity condensed in a non-compound engine. If there is conclusive proof to the contrary, derived from actual experiment, and not from mathematical considerations based on thermal laws, it has escaped our attention, and we shall be glad to be reminded of it. In the case of the Mullhouse engine, at the end of the stroke, much of the condensed steam was found to have been re-evaporated. With the small measure of expansion only 6·57 per cent. remained as water in the high-pressure cylinder, and with the large measure of expansion only 11·67 per cent. The re-evaporation began the moment the cut-off took place, and was the result of the fall in pressure; the heat "rendered latent," to use a somewhat convenient though erroneous expression, being derived from the sides and ends of the cylinder and piston.

Turning to the low-pressure cylinder, we find that at the end of the stroke of the piston 7·29 per cent. of the steam evaporated in the boiler was condensed in it when the ratio of expansion was 6·25 fold, while with the high ratio the weight of steam condensed rose to 10·52 per cent. Thus it will be seen that re-evaporation plays an important part in the compound just as it does in the non-compound engine; but we find no evidence in the entire cycle that condensation is reduced in quantity by the use of two cylinders instead of one. At this point comes Mr. Isherwood's explanation of the cause of the economy of the compound engine; and we quote his own words. "Of course, no work is obtained from the steam of the revaporised water of condensation that passes to the condenser during the exhaust stroke of the piston of the large cylinder, but the metal of the cylinder is chilled by this revaporisation, so that it acts as a condenser to the next charge it receives from the small cylinder. The re-evaporated steam which passed from the small cylinder to the large one during the exhaust stroke of the piston of the former was utilised upon the piston of the latter, and by fitting the large cylinder with a lap cut-off steam valve this re-evaporated steam was used expansively in that cylinder. The economic superiority of the compound engine over the simple one worked between the same boiler and condenser pressures, with the same measure of expansion and the same reciprocating speed of piston, *is due to the fact that the steam condensed in the small cylinder by the interaction of its metal is used upon the piston of the large one during its whole stroke, and expansively too if a cut-off be applied there.*" The italics are ours. In other words, the compound engine is economical, not because the condensation of steam is prevented, but because its re-evaporation is utilised in a way which is not quite so easily attained, if indeed it can be attained at all, in the single-cylinder engine. There can be no doubt that many persons have held views on this subject nearly identical with Mr. Isherwood's. We are ourselves among the number, but we are not aware that any writer has ever before put the proposition so clearly, concisely, and definitely. It must not be forgotten that although Mr. Isherwood is speaking of an engine with two cylinders only, the same reasoning will apply to the triple expansion engine. We are thus brought face to face with what is virtually a new theorem, namely, that the best way to secure economy in steam engine practice lies not so much in avoiding cylinder condensation, as in taking care that the work done in re-evaporation shall be utilised. Steam is condensed at one pressure, comparatively high, and it is revaporised at another pressure comparatively low, and it may be argued that the work done by this low-pressure steam must be less than would have been done had no condensation taken place. This argument is sound, but it is not so important as may appear at first sight. Let us suppose, for example, that a pound of steam was received from a boiler and expanded in a non-condensing cylinder, so that no condensation other than that due to the performance of work took place. This being a constant quantity determined by the amount of work done and by nothing else we may neglect it. Let the initial pressure be 100 lb. absolute, then one pound of such steam can do without expansion 58,273 foot-pounds. If we expand it 6·2 times it can do 150,630 foot-pounds, or nearly three times as much as it did without expansion. But it may be shown that the work done during expansion is very little affected by the pressure of the steam. Between the extremes of 65 lb. to 165 lb. on the square inch, Mr. Clark has shown that the difference of efficiency is not more than about 2½ per cent. in favour of the higher pressure. If, then, one-tenth of all the steam admitted to the cylinder be condensed during the steam stroke, and re-evaporated and *worked expansively* during the exhaust stroke, the loss caused by the initial condensation may be very small. The initial pressure may be 100 lb., corresponding to a temperature of 328 deg.; but the total heat given up by one pound of this steam condensed cannot be more than 1181 deg. and will be considerably less in proportion as the cylinder is hotter than 32 deg. The total heat required to reconvert this condensed 100 lb. steam into steam of, say, 30 lb. pressure will be 1158 deg., or 26 deg. less. That is to say, the heat surrendered during condensation by a pound of steam of one pressure is amply sufficient to produce another pound of steam at a somewhat lower pressure—a fact the truth of which is demonstrated, indeed, every day by the use of steam for evaporating purposes. If, then, the cylinder is prevented from parting with any of the heat surrendered by the steam during condensation on one stroke, and is able to give back all it received during the next stroke, then there will be a very small loss. This is an important proposition, and we may be excused if we try to make it quite intelligible. Let us suppose that we have a cylinder, into which a given quantity of steam is admitted. A portion of this is condensed while the piston is making a stroke. The pressure is 100 lb. on the square inch, and the quantity condensed is one-tenth of the whole. Let us suppose, now, that when one-half the stroke has been completed, the exhaust port is opened for an instant, and the whole of the steam suffered to escape, the exhaust port being then instantly closed. The pressure being reduced, condensed water would instantly be re-evaporated behind the piston, by its own heat and that of the metal of the cylinder, and it would be as competent to do work on the piston and push it further up in the cylinder as if no condensation whatever had taken place. We repeat, therefore, that it is evident that, do what we will in the way of jacketting, &c., initial cylinder condensation must take place. It becomes extremely important to see that re-evaporation occurs under conditions which will ensure the utilisation of the steam so re-evaporated. If it is suffered to escape directly to the condenser or the atmosphere it cannot do work of any useful kind.

It may be urged that re-evaporation in a single cylinder will have just the same efficient effect as though the re-made steam were used in a second cylinder; but a little thought will show that this cannot be the case. In the single cylinder the re-made steam is not used expansively. The conditions are just the same as though the steam followed the piston direct from the boiler. Indeed, if anything, the conditions are more unfavourable, the steam acting much as it does when a re-admission takes places through the faulty working of a slide valve after it has nominally cut the supply off. An inspection of a diagram from a single cylinder with an early cut-off will prove this, the expansion curve continuously rising above the Marriott curve. The practical deduction to be drawn is that it is a matter of no moment in the compound engine how much condensation takes place in the high-pressure cylinder, since the cylinder cannot condense more steam in one stroke than it can re-evaporate in the next, provided there is no loss by external radiation. In the low-pressure cylinder, on the contrary, every possible means should be adopted to prevent condensation, since in it condensation represents a dead loss, all the steam due to re-evaporation going straight to the condenser without doing any work whatever. A further lesson to be learned is that the statement made by Rankine, and all other writers on the theory of heat engines, that the number of cylinders employed does not affect the economical result, is only true for engines working with a permanent gas such as air, and is not true in practice of an engine working with a fluid like steam in a state of unstable equilibrium.

NEW HYDRAULIC FORMULÆ.

By W. Donaldson, C.E.

The ordinary formula for the uniform velocity of flow in pipes and open channels is of the form

$$v = A\sqrt{r s}$$

in which v is the velocity in feet per second, r the hydraulic mean radius in feet, and s the rate of inclination. This formula is based on the assumption that the retarding force of friction is directly proportional to the square of the velocity at any instant, and inversely proportional to the hydraulic mean radius. When the velocity, therefore, has reached its maximum value due to the rate of inclination and size and shape of the channel, the retarding force of friction is constant, and on the above hypothesis is equal to $\frac{c\,v^2}{r}$, c being a constant determined by experiment. Since the angle θ between the horizontal and the line of the direction of the pipes is always small, the accelerating force of gravity is equal to $g\sin.\theta = g\tan.\theta = g\,s$, and this, when the velocity is constant, must be equal to the force of retardation due to friction. Therefore

$$\frac{c\,v^2}{r} = g\,s,$$

whence

$$v = A\sqrt{r s}$$

the ordinary formula. Now it has been found by experiment that the value of A is not constant, but varies with the varying values of the hydraulic mean radius. D'Arcy and Bazin assume that A is a function of r of the form—

$$\frac{1}{\sqrt{A + \frac{B}{r}}}.$$

So that A has an appreciably different value for every section. In considering this question it struck me that the necessity of adopting this varying value of A arose from assuming that for all sizes of pipes the retardation caused by friction is inversely as the first power of the hydraulic mean radius, and that a formula of the form—

$$v = A\,r^n\sqrt{s}$$

might be obtained which would give the same values for v as those ascertained experimentally for wide ranges of the value of the hydraulic mean radius, the constant A and index n being taken as the mean of a series of values.

Before giving a description of the method I adopted for determining these values, I propose to discuss briefly the question, Does the retardation caused by friction vary as the square of the uniform velocity or simply as the first power? I believe that some authorities maintain the last law to be correct. It is a point which can be set at rest by experiments in any pumping station from which the rising main is free from obstructions, sudden contractions or enlargements, and ought not therefore to be a question in dispute. I have never availed myself of many opportunities of doing this, but a friend has given me the following particulars, which I think have enabled me to settle the question.

The engines referred to are beam engines of the very best construction, which, working at the rate of 14 strokes per minute, deliver 2100 gallons per minute, reckoning the full discharge of the pumps without any allowance for slip. The rising main is 24in. in diameter and one mile five furlongs in length. The velocity for a discharge of 2100 gallons is 21·7in. per second, which, according to Kutter for smooth pipes, corresponds to a gradient of 1 in 2600, and for brick sewers of 1 in 1800, so that the height due to friction would be somewhere between 3·3ft. and 4·7ft., and the horse-power necessary to overcome the friction would be somewhere between 2·1-horse power and 3-horse power. Allowing 10 per cent. for slip, the corresponding horse-power would be between 1·5-horse power and 2-horse power. When one engine only is working at the rate of 14 strokes per minute, the average indicated horse-power is 55½-horse power, and the net work done in pump cylinders 34⅜-horse power. When both engines are working at the rate of 14 strokes a minute, the average indicated horse-power is 63½-horse power. If, then, E_1 E_2 represent the friction of machinery in the two cases, and F_1 F_2 the friction in the clear run of the pipes, we have the following equations, viz.:—

$$34\tfrac{3}{8} + E_1 + F_1 = 55\tfrac{1}{2}$$
$$34\tfrac{3}{8} + E_2 + F_2 = 65\tfrac{1}{2}$$

Also since the work due to machinery friction varies as the amount of work done,

$$\frac{E_1}{E_2} = \frac{55\frac{1}{2}}{63\frac{1}{2}}$$

and if friction varies as the square of the velocity,

$$F_2 = 4F_1.$$

From these four equations we get

$F_1 = 1·7$-H.P. $F_2 = 6·8$-H.P.
$E_1 = 19·5$-H.P. $E_2 = 22·3$-H.P.

The value of F_1, determined from the pumping machinery data, agrees with the value determined from the formula for pipe friction. The work done in overcoming machinery friction would be equal to 35 per cent. of the indicated engine power, and in actual weight of water raised to 65 per cent. of the indicated engine power, or the indicated engine power would on this assumption be about one and a-half times the actual horse-power in water lifted, which is an ordinarily accepted ratio in the case of beam engines of the best type. We may therefore consider that this experiment proves, so far as one experiment can prove a rule, that the friction varies as the square of the velocity.

Kutter found in the great majority of the results of the experiments on the flow of water in rivers and channels that the velocity varied as the square root of the inclination, a few as the cube root, and a few as the fourth root. In the new American formula of Humphreys and Abbot the velocity is supposed to vary as the fourth root of the inclination, but the experimental results which appear to confirm this value have been obtained principally by observations in the flow in the Mississippi system, which have an extremely low inclination. Kutter only found fourteen cases confirming this theory, and the apparent confirmation is no doubt due to errors of observation. It must be extremely difficult to note with minute accuracy the fall in a mile of length of any river. When the fall amounts to several inches, a small error would not appreciably affect the result, but an error of $\frac{1}{10}$in. would be important when the whole fall is less than an inch.

Kutter gives the values of the constant m in the formula $v = m \sqrt{s}$ for pipes and channels of various dimensions of four descriptions, viz.: Table I., very smooth surfaces of pure cement, well-planed timber, &c.; II., smooth surfaces, ashlar brickwork, planking, &c.; III., moderately well constructed sections in rubble; IV., sections in earth.

Now m is the value of the expression $A r^n$ in the formula $v = A r^n \sqrt{s}$, and by equating this to the tabular values corresponding to successive values of r and $2r$, we shall obtain a series of equations which will give the values of 2^n, and therefore of n corresponding to the series of values of the hydraulic mean radius given in the tables. If the mean value of a group of these is selected, the extreme values of which do not differ by more than 10 per cent., the value of the expression $A r^n$ cannot differ by more than 5 per cent. from the values given in the tables, if the value of A is also a mean between the values necessary to satisfy the two extremes, and the formula so determined would be practically identical with Kutter's formulæ. Thus, for the sake of illustration, take the case of the range in the value of r from ·05 to ·01 in Table I.

For the value ·05 $A r^n = 19{\cdot}24$

„ „ ·1 $A\, 2^n r^n = 33{\cdot}33$

whence $2^n = \frac{33{\cdot}33}{19{\cdot}24} = 1{\cdot}73$

$n = {\cdot}8.$

Also for the value ·05 $A\,({\cdot}05)^{\cdot 8} = 19{\cdot}24$

$A = 212$

„ „ „ ·1 $A\,{\cdot}1^{\cdot 8} = 33{\cdot}33$

$A = 210$

The mean value of A is therefore 211, and the formula for values of r from ·05 to ·1 is

$$v = 211\, r^{\cdot 8} \sqrt{s}.$$

The four following tables give the formula corresponding to the data given in Tables I., II., III., and IV. of Kutter's work.

Table I.—*Very Smooth Surfaces of Pure Cement, &c.*

Range in values of r.	Corresponding formulæ.
·01 to ·05	$v = 284\, r^{\cdot 9} \sqrt{s}$
·05 to ·1	$v = 211\, r^{\cdot 8} \sqrt{s}$
·1 to ·2	$v = 168\, r^{\cdot 7} \sqrt{s}$
·2 to 1·5	$v = 141\, r^{\cdot 6} \sqrt{s}$
1·5 to 100	$v = 148 \sqrt{r s}$

Table II.—*Smooth Surfaces of Good Brickwork, &c.*

·01 to ·05	$v = 250\, r \sqrt{s}$
·05 to ·1	$v = 183\, r^{\cdot 9} \sqrt{s}$
·1 to ·2	$v = 145\, r^{\cdot 8} \sqrt{s}$
·2 to ·5	$v = 125\, r^{\cdot 7} \sqrt{s}$
·5 to 2	$v = 117\, r^{\cdot 6} \sqrt{s}$
2 to 100	$v = 128 \sqrt{r s}$

Table III.—*Good Rubble Channels.*

·05 to ·1	$v = 123\, r \sqrt{s}$
·1 to ·4	$v = 97\, r^{\cdot 9} \sqrt{s}$
·4 to 1	$v = 88\, r^{\cdot 8} \sqrt{s}$
1 to 2	$v = 87\, r^{\cdot 7} \sqrt{s}$
2 to 20	$v = 88\, r^{\cdot 6} \sqrt{s}$
20 to 100	$v = 116 \sqrt{r s}$

Table IV.—*Sections in Earth.*

·5 to 2	$v = 48\, r^{\cdot 9} \sqrt{s}$
2 to 4	$v = 50\, r^{\cdot 8} \sqrt{s}$
4 to 8	$v = 59\, r^{\cdot 7} \sqrt{s}$
8 to 16	$v = 73\, r^{\cdot 6} \sqrt{s}$
16 to 100	$v = 102 \sqrt{r s}$

The above formulæ are only apparently unsymmetrical. The numerical coefficients involve the factor $\sqrt{g}$, and s is equivalent to the fall in a unit of length, whilst r is simply the ratio of the value of the hydraulic mean radius of the section to unity, the value of the mean radius of an assumed standard section.

For circular pipe sewers the formulæ in Tables I. and II. may be transformed into the following shape, in which d is equal to the diameter of the pipe in inches, and v is the velocity in inches per second:—

Table I.—*Very Smooth Pipes.*

Range in diam. of pipes.	Formulæ.
½in. to 2½in.	$v = 107\, d^{\cdot 9} \sqrt{s}$
2½in. to 5in.	$v = 115\, d^{\cdot 8} \sqrt{s}$
5in. to 10in.	$v = 134\, d^{\cdot 7} \sqrt{s}$
10in. to 72in.	$v = 166\, d^{\cdot 6} \sqrt{s}$
6ft. to 400ft.	$v = 256 \sqrt{d s}$

Table II.—*Moderately Smooth Pipes and Brick Sewers.*

½in. to 2½in.	$v = 63\, d \sqrt{s}$
2½in. to 5in.	$v = 68\, d^{\cdot 9} \sqrt{s}$
5in. to 10in.	$v = 78\, d^{\cdot 8} \sqrt{s}$
10in. to 24in.	$v = 100\, d^{\cdot 7} \sqrt{s}$
24in. to 96in.	$v = 138\, d^{\cdot 6} \sqrt{s}$
8ft. to 400ft.	$v = 221 \sqrt{d s}$

The following table gives a comparison between the velocities due to a gradient of 1 in 900 for various sizes of pipes, from 3in. to 96in. diameter, obtained from Kutter and Neville:—

Table of Comparison.

	In.	In.	In.	In.	In.	In.	In.	In.	In.
Diameters	3	4	5	6	7	8	9	10	12
Kutter, Table I.... ...	9	12	14	16	18	19	21	23	25
Kutter, Table II. ...	6	8	10	11	12	14	15	17	19
Neville	9	10	12	13	14	15	16	17	19

Table of Comparison (continued.)

	In.	In.	In.	In.	In.	In.	In.	In.	In.
Diameters	14	16	18	21	24	27	30	36	96
Kutter, Table I.... ...	27	29	31	35	37	40	43	48	84
Kutter, Table II. ...	21	23	25	28	31	33	36	40	72
Neville	20	22	23	26	27	29	31	33	55

THE PROPERTIES OF GASEOUS EXPLOSIVE MIXTURES.*

The splendid researches of Berthelot and his *confrère* Vieille upon the subject of "Mecanique Chimique" are of the utmost importance to engineering science. Berthelot's magnificent book on this subject contains a mine of wealth to the investigator, and his continual exhaustive researches since the publication of this work has resulted in the discovery of many facts which have relieved this subject from much of its obscurity, and disproved the accuracy of many thermo-dynamic formulæ.

The discovery of the degrees of increase of specific heat due to increase of temperatures will nullify the results of many investigations as to the comparative efficiency between different applications for generating heat and transforming it into useful work.

The following data, in addition to that already published, will doubtless be useful:—

Pressures Developed by Various Gaseous Explosive Mixtures.

In the experiments, three cylinders of different capacity were used, the smallest one, called S C for convenience, had a capacity of 300 cc.; the medium one, called M C, had a capacity of 1·5 lit.; and the larger one, L C, had a capacity of 4 lit.

It will be at once apparent on examination of the figures that a considerable increase of pressure was obtained by the larger cylinders owing to the lesser ratio of the wasteful radiating surface to the cubical capacity.

Nature of gaseous mixtures.	Ratio of absolute pressures.
$H+O$	$\frac{S.C}{L.C}\ \frac{7{\cdot}41}{9{\cdot}69} = 0{\cdot}76$
$H+O+N$	$\frac{S.C}{L.C}\ \frac{7{\cdot}60}{8{\cdot}63} = 0{\cdot}88$
$H+O+2N$	$\frac{S.C}{L.C}\ \frac{7{\cdot}34}{7{\cdot}55} = 0{\cdot}95$
$H+O+3N$	$\frac{S.C}{L.C}\ \frac{6{\cdot}12}{6{\cdot}64} = 0{\cdot}92$
$CO+O$	$\frac{S.C}{L.C}\ \frac{9{\cdot}29}{9{\cdot}93} = 0{\cdot}93$
$C^4 H^4 + O^{12}$	$\frac{S.C}{L.C}\ \frac{14{\cdot}18}{15{\cdot}73} = 0{\cdot}90$
$C^2 H^4 + O^8$	$\frac{S.C}{L.C}\ \frac{13{\cdot}94}{14{\cdot}81} = 0{\cdot}94$
$C^2 N + O^2 + \frac{79}{21} N$	$\frac{S.C}{M.C}\ \frac{10{\cdot}6}{12{\cdot}02} = 0{\cdot}88$
$C^2 N + O^2 + N^2$	$\frac{S.C}{M.C}\ \frac{13{\cdot}88}{15{\cdot}56} = 0{\cdot}89$
$C^2 N + O^2 + \frac{3}{4} N$	$\frac{S.C}{M.C}\ \frac{18{\cdot}65}{21{\cdot}09} = 0{\cdot}88$

Bunsen's experiments with different apparatus gave results similar to those of Berthelot and Vieille; for instance, $C^2 O^2 + O^2$ gave a pressure of 10·5 atmospheres; Berthelot and Vieille's experiments gave 10·10. For $H^2 + O^2$ Bunsen obtained 9·97 atmospheres; Berthelot and Vieille obtained 9·80. Mallard and Chatelier† obtained for $C^2 O^2 + O^2$ containing 0·012 water vapour, 9·95 atmospheres, while Berthelot and Vieille obtained 10·1 with dry gas.

In the following tables, showing pressures developed by various gaseous mixtures, the initial gaseous mixtures were reduced to a temperature of 0 deg., and at 760mm. pressure. Each experiment was repeated at least twice, and sometimes as often as five or six times:—

First Group.—Hydrogenated Mixtures.

I.—*Hydrogen and Oxygen.*

(1) H^2+O^2 ... ... 9·80 atmospheres.
(2) $H^2+O^2+H^2$ ... ... 8·82 „
(3) $H^2+O^2+2\,H^2$ ... ... 8·02 „
(4) $H^2+O^2+3\,H^2$ ... ... 7·06 „
(5) $H^2+O^2+O^4$ ... ... 8·69 „
(6) $H^2+O^2+3\,O^4$ ... ... 6·78 „

II.—*Hydrogen, Nitrogen, and Oxygen.*

(7) $H^2+O^2+\frac{1}{2}\,N$ ... ... 9·16 atmospheres.
(8) $H^2+O^2+N^2$ ... ... 8·75 „
(9) $H^2+O^2+2\,N^2$ ... ... 7·94 „
(10) $H^2+O^2+3\,N^2$ ... ... 6·89 „

III.—*Hydrogen and Protoxide of Nitrogen.*

(11) $H^2+N^2 O^2$ ... ... 13·60 atmospheres.
(12) $H^2+N^2 O^2+N^2$ ... ... 11·08 „

Second Group.—Oxycarbonic Mixtures.

I.—*Carbonmonoxide and Oxygen.*

(13) $C^2 O^2+O^2$ ... ... 10·12 atmospheres.

II.—*Carbonmonoxide, Nitrogen, and Oxygen.*

(14) $C^2 O^2+N+O^2$ ... ... 9·33 atmospheres.
(15) $C^2 O^2+N^2+O^2$ ... ... 8·77 „
(16) $C^2 O^2+5\,N+O^2$ ... ... 7·05 „

III.—*Carbonmonoxide and Protoxide of Nitrogen.*

(17) $C^2 O^2+N^2 O^2$ ... ... 11·41 atmospheres.

IV.—*Hydrocarbon Mixtures.*

(18) $C^2 O^2+H+O^3$ ... ... 9·81 atmospheres.
(19) $C^2 O^2+H^2+O^4$ ... ... 8·79 „
(20) $C^2 O^2+H^3+O^5$ ... ... 9·44 „
(21) $C^2 O^2+H^4+O^6$ ... ... 9·61 „

Third Group.—Cyanogenes.

I.—*Cyanogen and Oxygen: Total Combustion.*

(29) $C^4 N^2+O^8$ ... ... 20·96 atmospheres.

II.—*Cyanogen, Nitrogen, and Oxygen: Total Combustion.*

(30) $C^4 N^4+N^2+O^3$ ... ... 17·70 atmospheres.
(31) $C^4 N^2+2N^2+O^8$ ... ... 14·74 „
(32) $C^4 N^2+4N^2+O^8$ ... ... 12·33 „

* Translated and abstracted by B. H. Thwaite, C.E., F.C.S., from the *Annales de Chimie et de Physique*, January, 1885.

† Mallard et Le Chatelier, "Recherches Expérimentales," &c., p. 125.

III.—*Cyanogen, Oxygen, and Nitrogen: Incomplete Combustion.*

(33) $C^4 N^2+O^4$ ... ... 25·11 atmospheres.
(34) $C^4 N^2+1\frac{1}{2}\,N+O^4$ ... ... 20·67 „
(35) $C^4 N^2+2\,N^2+O^4$ ... ... 15·26 „
(36) $C^4 N^2+\frac{72}{21}\,N^2+O^4$ ... ... 11·78 „

IV.—*Cyanogen Carbonmonoxide and Oxygen: Incomplete Combustion.*

(37) $C^4 N^2+1\frac{1}{2}\,C\,O \times O^4$ ... ... 21·24 atmospheres.
(38) $C^4 N^2+2\,C^2 O^2+O^4$ ... ... 15·46 „

V.—*Cyanogen and Compound Comburant Gases: Total Combustion.*

(39) $C^4 N^2+4\,N\,O^2$ ... ... 16·92 atmospheres.
(40) $C^4 N^2+4\,N^2 O^2$ ... ... 22·66 „

VI.—*Cyanogen and Comburant Gases: Incomplete Combustion.*

(41) $C^4 N^2+2\,N\,O^2$ ... ... 23·34 atmospheres.
(42) $C^4 N^2+2\,N^2 O^2$ ... ... 26·02 „

This last pressure is the greatest which has been obtained with gaseous mixtures taken under the normal pressure.

Fourth Group.—Carburettes of Hydrogen.

I.—*Pure Gases.*

(22) $C^4 H^2+O^{10}$ ... ... 15·29 atmospheres.
(23) $C^4 H^4+O^{12}$ ... ... 16·13 „
(24) $C^3 H^6+O^{14}$ ... ... 16·18 „
(25) $2\,C^2 H^4+O^{16}$ ... ... 16·34 „

II.—*Other Mixtures.*

(26) Ethyline and hydrogen $C^4 H^4+H^2+O^{14} = 14{\cdot}27$ atmos

III.—*Gases containing Oxygen.*

(27) Ether (methylic) $C^4 H^6 O^2+O^{12}$... 19·91 atmospheres
(28) Ether (ordinary) $C^8 H^{10} O^2+O^{12}$... 16·33 „

The Specific Heat of Gaseous Elements at very High Temperatures.—*Cyanogenes.*

Gaseous mixtures.	Pressure developed (reduced).	Heat disengaged	Temp. (Centigrade).	Specific heat. Total.	Specific heat. For N^2 & C O
	atmos.	calories.	deg.		
$C^4 N^2+O^4$	25·11	126·500	4394	28·81	9·600
$C^4 N^2+O^4+1\frac{1}{2}\,N^2$	20·67	126·500	4024	31·46	8·39
$C^4 N^2+O^4+2\times N^2$	15·26	126·500	3191	39·67	7·93
$C^4 N^2+O^4+\frac{72}{21}\,N^2$	11·78	126·500	2810	45·05	6·67
$C^4 N^2+2\,N\,O^2$ ..	23·34	169·800	4309	39·39	9·85
$C^4 N^2+2\,N^2 O^2$ ..	26·02	168·400	3993	42·17	8·43

It will be noticed that there exists a considerable connection between the numbers obtained, whether with pure oxygen, with binoxide or with the protoxide of nitrogen at the same temperature and under the same pressures. Thus towards 4400 deg. we find that with pure oxygen the specific heat = 9·60, with binoxide of nitrogen the specific heat = 9·85; the ratio between the nitrogen and the carbonmonoxide was as 1 : 1 in volumes towards 4000 deg., with pure oxygen 8·43, the ratio between the nitrogen and the carbonmonoxide being as 3 : 2.

The following figures may be taken as expressing the molecular specific heats, at high temperatures and constant volumes, of the following simple gases:—

Nitrogen, hydrogen (H^2); oxygen, O^4, as well as the compound carbonmonoxide ($C^2 O^2$), which is assimilated to them. The figures calculated were obtained by the following formulæ, where C is the specific heat and t the temperature.

$$C = 6{\cdot}7 + 0{\cdot}0016\,(t - 2800)$$

	Specific heat. Calculated.	Specific heat. Found.
2800 deg.	6·7	6·7
3200 deg.	7·3	7·9
4000 deg.	8·6	8·4
4400 deg.	9·3	9·6

The pressure measurements indicated that the oxygen would have a specific heat slightly superior to that of the hydrogen—or about 1·5 hundredths, or thereabouts—in fact, it was found that

{ $H^2 + O^2 + H^2$ gave 8·82 atm.
{ $H^2 + O^2 + O^4$ „ 8·69 „
{ $H^2 + O^2 + 3\,H^2$ „ 7·06 „
{ $H^2 + O^2 + 3\,O^4$ „ 6·78 „
{ $H^2 + O^2 + 3\,N^2$ „ 6·89 „

The concordance of Berthelot's and Vieille's experiments with those of Mallard and Le Chatelier is shown by the formula established by these latter savants, in which C is the specific heat and t the temperature—

$$C = 4{\cdot}8 + 0{\cdot}0006\,t.$$

This gives, at 2800 deg.,

$$C = 6{\cdot}48 \text{ exactly.}$$

Berthelot and Vieille's experiments gave

$$C = 6{\cdot}7.$$

Berthelot and Vieille established an empirical formula for the mean specific heat as follows:—

$$4{\cdot}75 + 0{\cdot}0016\,(t - 1600).$$

This gives for elementary gases mentioned, *i.e.*, N. H. O., and C O.—

At 2000 deg. = 6·1
At 3000 deg. = 9·3
At 4000 deg. = 12·5
At 5000 deg. = 15·7

Water Vapour Calculated by above Formulæ.

Gaseous Mixtures.	T temperatures.	Total specific heat.	Specific heat of nitrogen	Molecular mean specific heat of $H^2 O^2$ between O° and T.
	deg.			
H^2+O^2	3240	18·12	—	18·12
$H^2+O^2+\frac{1}{2}\,N$	2860	20·52	1·69	18·83
$H^2+O^2+N^2$	2543	23·08	6·26	16·82
$H^2+O^2+2N^2$	2180	26·93	11·36	15·57
$H^2+O^2+3N^2$	1798	32·05	15·21	16·84
$H^2+N^2 O^2$	3133	25·09	7·20	17·89
$H^2+N^2 O^2+N^2$	2601	30·60	12·70	17·90

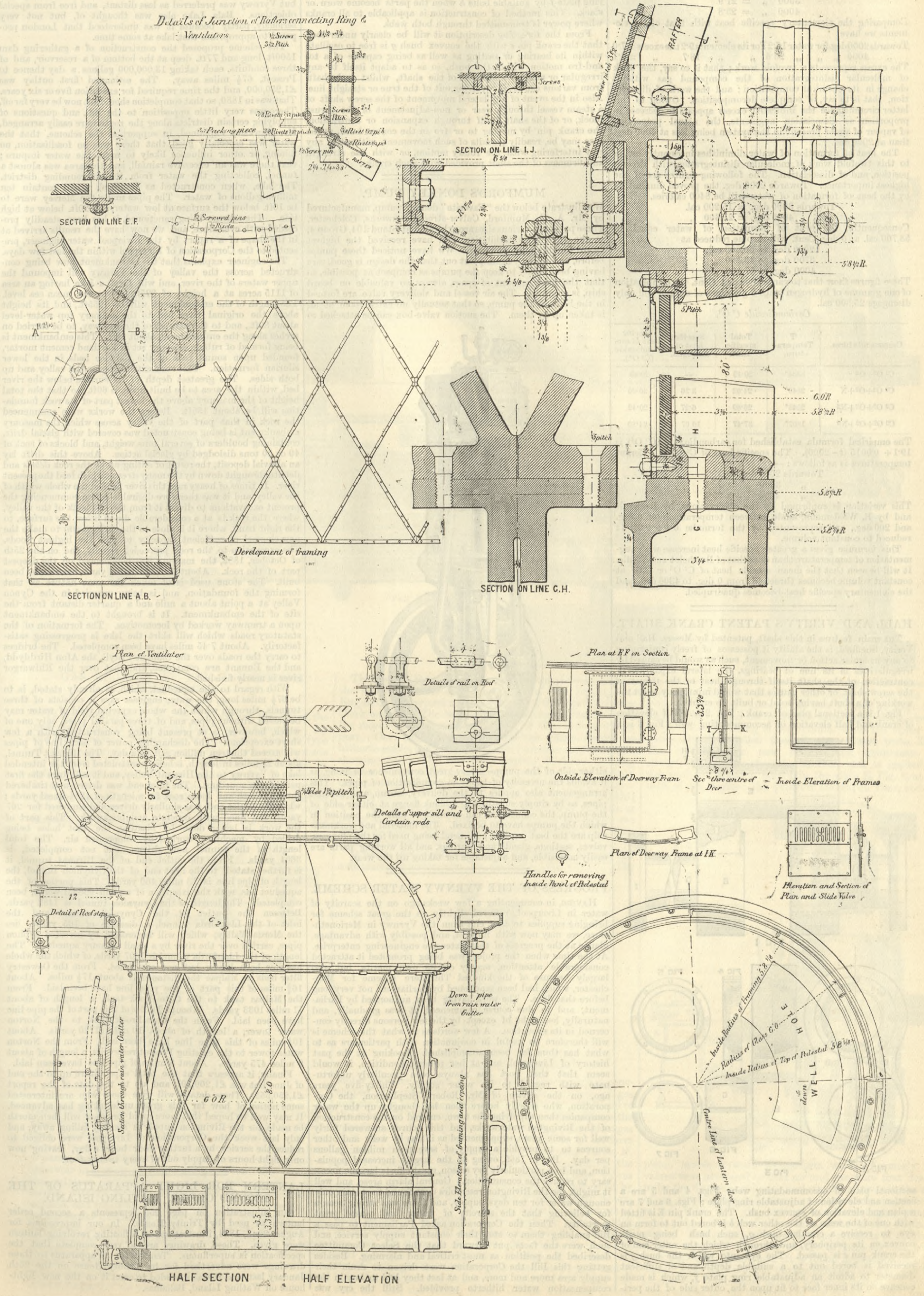
Messrs. Mallard and Le Chatelier have valued the specific heat of water at 16·6 for a temperature of 3350 deg. In supposing dissociation does not occur at this temperature, this result sufficiently accords with that of Berthelot and Vieille.

It will be seen that the mean specific heat of aqueous vapour at constant volume increases with the temperature rather slowly, however, and conforms to the empirical formula

$$16{\cdot}2 + 0{\cdot}0019\,(T - 2000).$$

LANTERN FOR LIGHT APPARATUS OF THE SECOND ORDER, WATLING ISLAND, BAHAMAS.

(For description see page 256.)



The mean specific heat of water vapour between 130 deg. and 230 deg. at constant volume may be valued at 6·65, consequently it will be more than double towards 2000 deg., or increased threefold towards 4000 deg. The elementary specific heat towards 2000 deg. = 16·2
3000 „ = 20·0
3500 „ = 21·9
4000 „ = 23·8

Comparing the elementary specific heat with that of its elements we have

Towards 2000 deg. for water 16·2 For its elements 9·2 the excess = 7·0
„ 4000 „ „ „ 23·8 „ „ 18·7 „ = 5·1

The excess represents a twofold work; that is to say, the work of molecular disintegration of the compound gas without change in its chemical composition; and the work of dissociation, that is to say, of complete decomposition. Owing to this latter circumstance the indicated excess appears to decrease in proportion as dissociation augments, the actual proportion of vapour of water present in the system being less at 4000 deg. than at 2000 deg.

The heat of formation of water diminishes incessantly owing to this twofold work of molecular disintegration with decomposition, and of dissociation. The following figures are of the highest importance. Towards 2000 deg. the proved diminution by the heat of formation of water will be 8400 calories.

Towards 3000 deg. = 15,200 cal.
„ 4000 deg. = 21,600 „

Consequently, the heat of formation of water equal to 58,700 cal. at 0 deg. Cent. will become reduced at

2000 deg. to 50,600 cal.
3700 deg. to 43,500 „
4000 deg. to 37,100 „

These figures show that towards 2000 deg. Cent. the combination of one gramme of hydrogen with 8 grammes of oxygen will only disengage 25,300 cal.

Carbondioxide $C\,O^2$.

Gaseous mixtures.	T Temperature.	Total specific heat.	Specific heat of nitrogen.	Specific heat of carbondioxide ($C^2\,O^4$).
$C^2\,O^2+O^2$	3334°	20·40	—	20·40
$C^2\,O^2+O^2+N$	2840°	24·02	3·36	20·66
$C^2\,O^2+O^2+N^2$	2548°	26·69	6·27	20·42
$C^2\,O^2+O^2+N^5$	1807°	37·47	16 67	24·80

The empirical formula established for carbondioxide ($C^2\,O^4$) is $19{\cdot}1 + 0{\cdot}0015\,(t-2000)$. The specific heat of $C^2\,O^4$ at different temperatures is as follows:—

Towards 2000 deg. = 19·1
„ 3000 „ = 22·1
„ 4000 „ = 25·1

This variation is confirmed by the observations, by Regnault and by E. Wiedemann, made between temperatures of 0 deg. and 200 deg., and represented by the formulæ $6{\cdot}4 + 0{\cdot}0106\,t$ reduced to constant volume.

This formulæ gives a greater specific heat increase with augmentation of temperature than does that of Berthelot and Vieille. It will be seen that the mean specific heat of $C^2\,O^4$ or $C\,O^2$ at constant volume becomes threefold from 0 deg. to 4300 deg., and the elementary specific heat becomes quadrupled.

HALL AND VERITY'S PATENT CRANK SHAFT.

The main feature in this shaft, patented by Messrs. Hall and Verity, Sheffield, is the ability it possesses of freely conforming to any irregular action or movement, such as would be caused by irregularities in its line of bearings, the lateral expansion or contraction of the shaft itself through heat or the thrust of the screw shaft, or other causes that would injuriously affect the working of a shaft having solid or built up cranks.

Fig. 1 is a sectional plan of crank; Fig. 2 is a half elevation of crank and half elevation of accommodating web; Fig. 3 is a

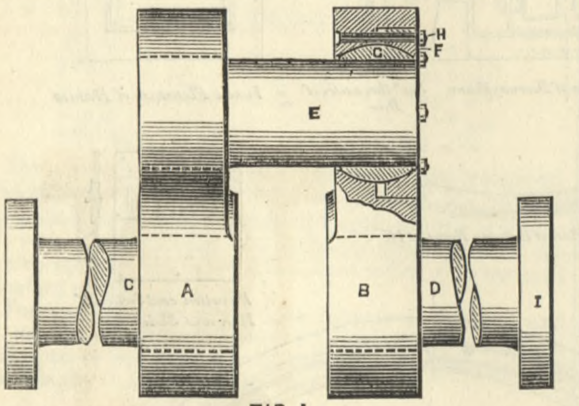


FIG 1

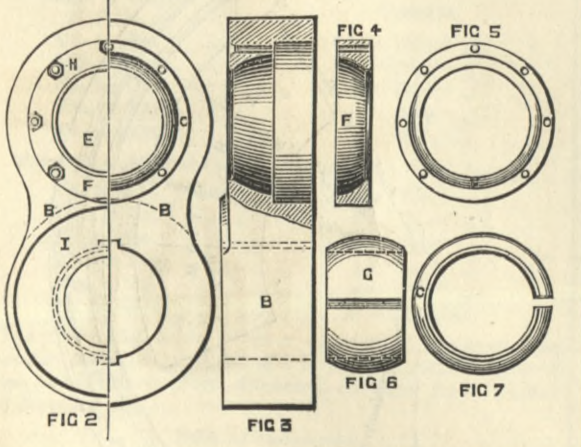


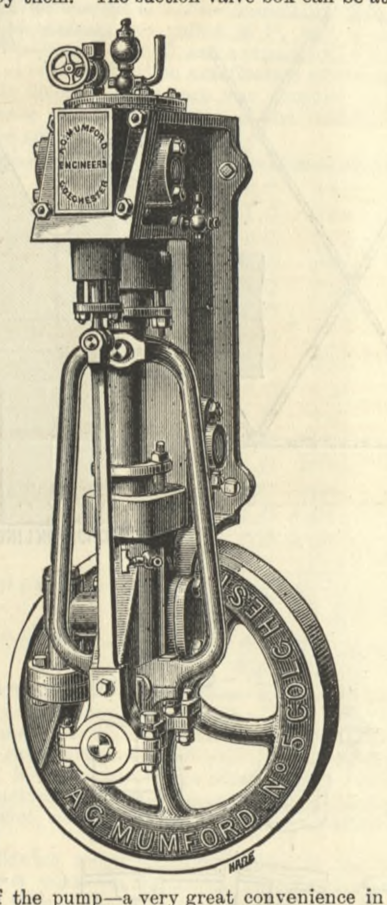
FIG 2 FIG 3 FIG 6 FIG 7

sectional plan of accommodating web; Figs. 4 and 5 are a section and elevation of adjustable ring plate; Figs. 6 and 7 are a plan and elevation of convex bush. The crank pin E is fitted with one of the webs *a*; the other web *b* is bored out to form an eye to receive a circular bush *g*, such bush being made convex on its periphery, and through which the outer end of the crank pin *e* is passed. The eye into which the bush *g* is received is bored out to a suitable depth, and of sufficient diameter to admit an adjustable ring plate *f*, which is made concave on its inner face to fit upon the outer side of the periphery of the convex bush *g*. A corresponding concave face is formed in the other portion of the eye, which, in conjunction with the ring plate *f*, forms a seating to receive the convex bush *g* and allows it to adjust itself as required. This bush is split, as shown in Figs. 6 and 7, to allow of its being compressed upon the crank pin *e* by the adjustment of the movable ring plate *f* by suitable bolts *h* when the parts become worn or slack. This method of construction is applicable to all cranks where power is transmitted through both webs.

From the foregoing description it will be clearly understood that the crank pin *e* with the convex bush *g* is free to oscillate within its bearing or seating as well as being capable of a to-and-fro motion within the bush, so as to adapt itself to any irregular or angular movement of the shaft, whilst such shaft, from various causes, is revolving out of the true or straight line. Also in the event of any lateral movement of the screw shaft of a steam vessel through wear or non-adjustment of the thrust block, or of the shaft itself through expansion or contraction, the crank pin by moving to or fro in the convex bush, as the case may be, readily permits of such movement without in any way interfering with the rotary motion, or with the strength and firmness of the shaft provided with such cranks.

MUMFORD'S DONKEY PUMP.

We illustrate below the "Favorite" donkey pump, manufactured by Mr. A. G. Mumford, Culver-street Ironworks, Colchester. These pumps in various sizes are exhibited at Stand 104, Group 4, at the Inventions Exhibition, and have received the highest award for this class of pump. We have noticed these pumps before, and we may again point out that the design is good, care having been taken to keep the pumps as compact as possible, so that the least amount of space, always so valuable on board ship, is occupied. The air vessel and delivery valve are formed in the body of the pump, so that actually no extra room at all is taken up by them. The suction valve-box can be attached to



either side of the pump—a very great convenience in fixing, as it avoids the necessity of bends or complication of pipes. This arrangement also applies to the delivery, steam, and exhaust pipes, as by simply substituting a blank flange at either side of the pump, the connections can be made to suit the position in which the pumps have to be fixed. The material and workmanship are the best possible, gun-metal being used for the plungers, valves, seatings, glands, and bearings, and all working parts are easily accessible, and adjustable for taking up the wear.

PROGRESS OF THE VYRNWY WATER SCHEME.

Having, in commenting a few weeks ago on the scarcity of water in Liverpool, referred slightly to the great scheme for bringing supplies to that city from the Vyrnwy in Merionethshire, we may now with interest, and possibly with advantage, glance at the progress of that extensive engineering enterprise. At the time when the project was being promoted it attracted considerable attention, mainly on its own merits, but also largely because of the kindred Thirlmere scheme for Manchester, which had been sanctioned by Parliament not very long before that date. The work having been authorised by Parliament, and in due course commenced, it was gradually, and naturally, lost sight of except by the few persons directly concerned in its execution. A few words as to what the scheme is will therefore be useful in conjunction with particulars as to what has thus far been accomplished. Looking at the past history of Liverpool, and at her present condition, it would seem that that port has always been peculiarly unfortunate with regard to its water supply. Thirty-five years ago, on the advice of Mr. Robert Stephenson, the Corporation, who shortly before then had bought up the water companies then supplying the town, entered on the construction of the Rivington waterworks, and this source answered fairly well for some years, supplemented as it was by wells and other sources to to provide a supply of seventeen million gallons per day. But in 1865, owing to the largely increased population, and to a particularly dry season, great efforts became necessary to reduce the consumption. General alarm arose, and well it might, for the Rivington reservoirs were found to contain only enough water for ten days' supply, and there was strong reason for believing that the scarcity of water had caused great mortality. Then the Corporation asked Parliament to pass a Bill enabling them to stop their constant supply service, and such were the facts put forward that the Select Committee described the position as most critical and alarming. Besides getting this Bill the Corporation were driven to drain their supply area more and more, and at last they had to buy in the compensation water hitherto provided. Still the cry was more water, and at length, with the assistance of Mr. Hawksley and Mr. Bateman, the Corporation fixed upon the Vyrnwy district, and brought in a Bill, which passed in three or four days in each House, giving them power to tap that source, just as Manchester was to draw from Thirlmere; Windermere, Haweswater, and some other places were at one time contemplated but Vyrnwy was preferred as less distant, and free from special objections. Bala Lake also was thought of, but not very seriously, partly because it was understood that London proposed to appropriate that lake at some time.

The scheme proposed the construction of a gathering dam 1500ft. long and 77ft. deep at the bottom of a reservoir, and of three conduits, each taking 13,000,000 gallons a day thence to Prescot, 67½ miles away. The estimated first outlay was £1,250,000, and the time required for execution five or six years. That was in 1880, so that completion should not now be very far off. There was very little opposition to the Bill, and questions of supplying certain districts along the route were easily arranged. Mr. Hawksley explained, in support of the scheme, that the water was especially good, that there was no fossilisation, no mining, or other influence likely to make the water impure; that there was an excessive rainfall, and the area was almost a funnel, collecting the water from the surrounding district. The lake, when constructed as proposed, would contain ten million gallons of water. The pipes under the Mersey were to be 10ft. below the surface at low water, and 20ft. below at high tide. The scheme being sanctioned, it has been steadily proceeded with ever since, and we now have the results arrived at in the shape of a report by the Liverpool water engineer, presented to the Corporation of Liverpool within the last few days.

The engineer explains that the embankment now being constructed across the valley of the Vyrnwy will impound the upper waters of the river, and will form a lake having an area of 1115 acres at a height of 825ft. above the mean sea level. The length of the embankment will be 1255ft., and its height above the original river bed to the ordinary top water-level about 80ft., and to the parapet of the roadway, to be carried on arches along the embankment, about 98ft. This embankment is being formed of rubble masonry set in Portland cement mortar, founded upon sound rock of the Caradoc beds in the lower silurian formation. This rock extends across the valley and up both sides. The greatest depth of its surface below the river bed, within the area to be built upon, is 60ft., so that the total height of the masonry above the lowest part of its rock foundation will be about 158ft. Before the works were commenced the rock in that part of the valley across which the masonry embankment is being constructed was covered with glacial drift, containing boulders of several tons weight, and blocks of rock of 40 or 50 tons dislodged by glacial action. Above this drift lay an alluvial deposit, the result of silting up by the rock *débris* and detritus brought down by the many streams which feed the present river. In times of heavy rain this river flooded the whole width of the valley, and it was therefore desirable before commencing the present excavations to divert it from the left bank of the valley, where the rock is at a considerable depth below the surface, to the right bank, where it is close to the surface, and to make the new channel of sufficient capacity to pass the highest floods. The excavation to the rock proceeded rapidly, and on the 25th of October, 1882, the masonry was commenced on the deepest part of the rock. About 126,765 cubic yards have since been built. The stone used is of much the same nature as that forming the foundation, and is being quarried in the Cynon Valley at a point about a mile and a quarter distant from the site of the embankment. It is brought to the embankment upon a tramway worked by locomotives. The formation of the statutory roads which will skirt the lake is progressing satisfactorily. About 7·45 miles have been completed. The bridges to carry the roads over the Cainant Pistyll, the Afon Hirddydd, and the Eunant are completed, and that over the Rhiwargor river is nearly finished.

With regard to the aqueduct, which, as already stated, is to be 67½ miles long, the water engineer says it consists of three tunnels, through which the whole expected yield of water may be passed without pipes, and of three parallel pipes, only one of which, however, is at present being constructed, with a few short exceptions. The discharging power of each line of pipes will exceed thirteen million gallons a day. The Hirnant Tunnel, about 2¼ miles in length, is being constructed from the intended lake of Vyrnwy to the Hirnant Valley, and it will form the first part of the aqueduct. The inlet end was driven and timbered through earth and loose rock for a length of 128½ lineal yards; while the outlet end was similarly driven and timbered for 267 yards, and lined with concrete and brickwork. This part of the work is being done by blasting, the shot holes being drilled by machines worked by compressed air. The total length of the tunnel now driven, but not completed, is 3604 yards. From the outlet end of the Hirnant tunnel, it is further stated, to the inlet end of the Cynynion tunnel, the length of pipe line is 13 miles 460 yards. This portion of the aqueduct has, with the exception of certain special works, been completed. The length of the Cynynion tunnel is 1482 yards. Between the outlet of the Cynynion tunnel and the inlet of the Llanforda tunnel, a distance of 165 yards, lies the Morda Valley, which will be crossed by inverted syphon pipes, carried over the river by a small masonry aqueduct. The length of the Llanforda tunnel is 1607 yards, of which the whole has now been driven but not completed. From the Oswestry filter beds to Malpas the distance is about 17½ miles. About 16¾ miles of this part of the pipe line have been laid. From the Malpas tank to the Cote-Brook tank, a length of about 11 miles 1033 yards. About 5¾ miles of this part of the pipe line have been laid. From the Cote-Brook tank to the Norton water tower, a length of about 10 miles 1720 yards. About 10¼ miles of this pipe line have been laid. From the Norton water tower to the existing Prescot reservoirs, a length of about 9 miles 475 yards. About 8 miles of pipe line have been laid.

Finally, it appears that the total expenditure up to the end of June last was £1,200,701, and up to the date of the report £1,250,555. These details will give those who are interested some notion of how far this great undertaking has advanced. It may well be hoped that more rapid progress will henceforth be made, for the Rivington supply is steadily falling away, and only last week the Corporation of Liverpool were obliged to reduce the service by a further four hours a day, leaving now only eight hours of supply out of every twenty-four.

LANTERN FOR LIGHT APPARATUS OF THE SECOND ORDER, WATLING ISLAND.

Our illustration on page 255 represents a second order lantern as used by Trinity House. In our impressions for August 22nd, 1884, illustrations of a floating revolving lantern were given. These drawings are so very complete that the specification is superfluous. Tenders for an apparatus to these drawings were advertised for by Trinity House on the 20th January last, and it was intended to erect it on the new lighthouse on Watling Island, Bahamas.

CLERK'S GAS ENGINE.

MESSRS. LOUIS STERNE AND CO., LONDON, ENGINEERS.

FIG. 1.

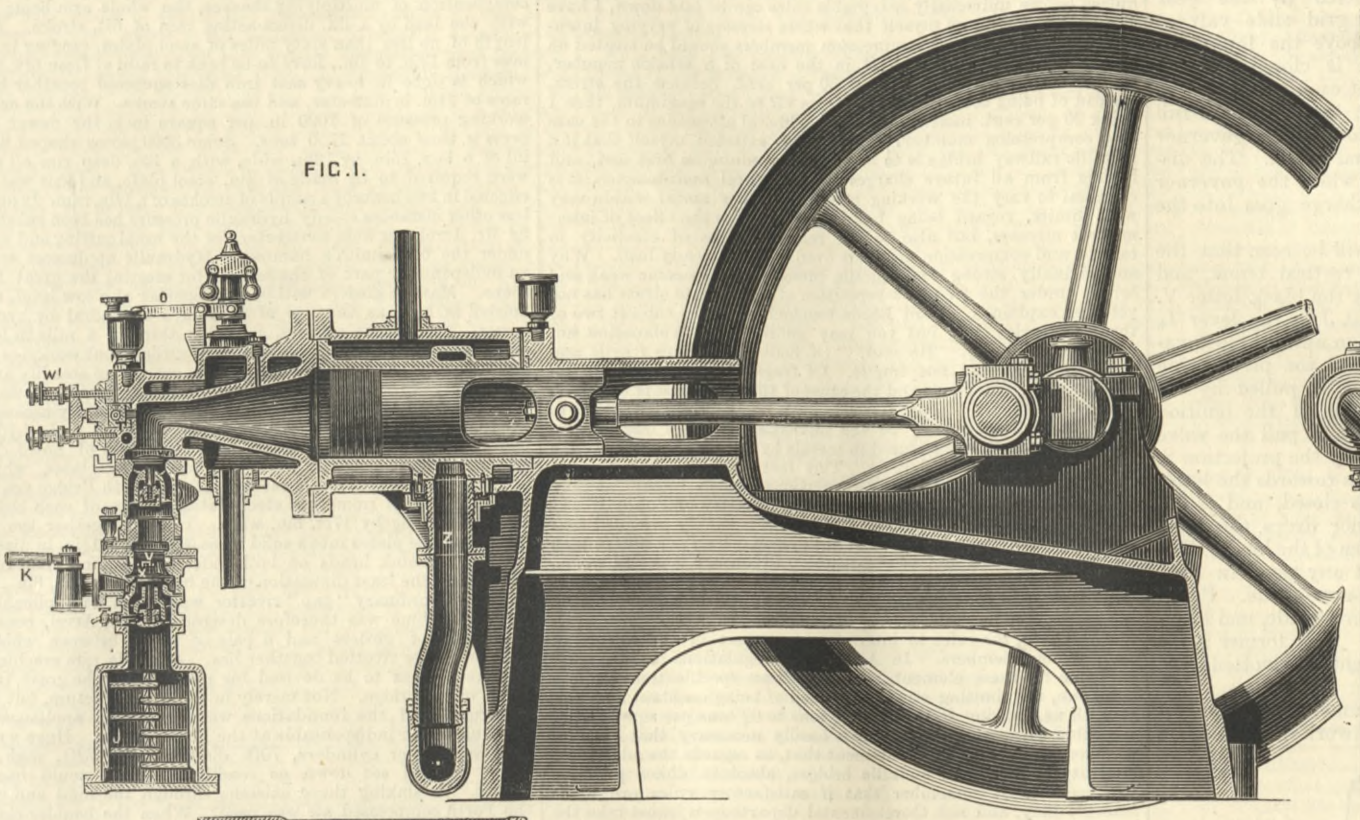
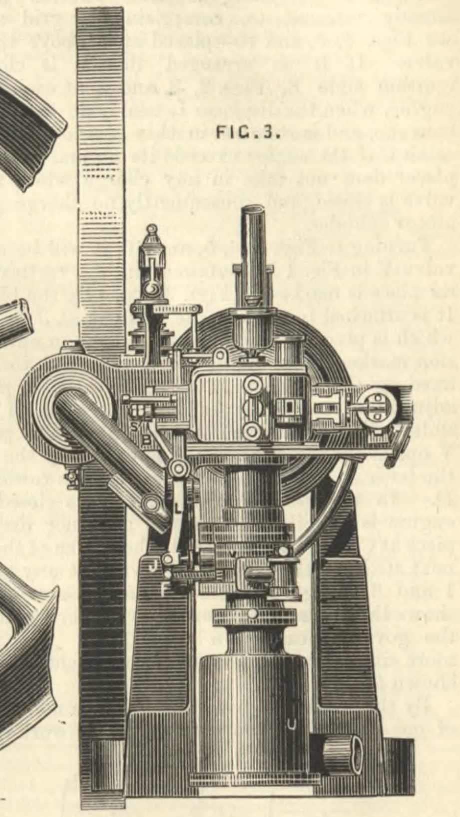


FIG. 3.



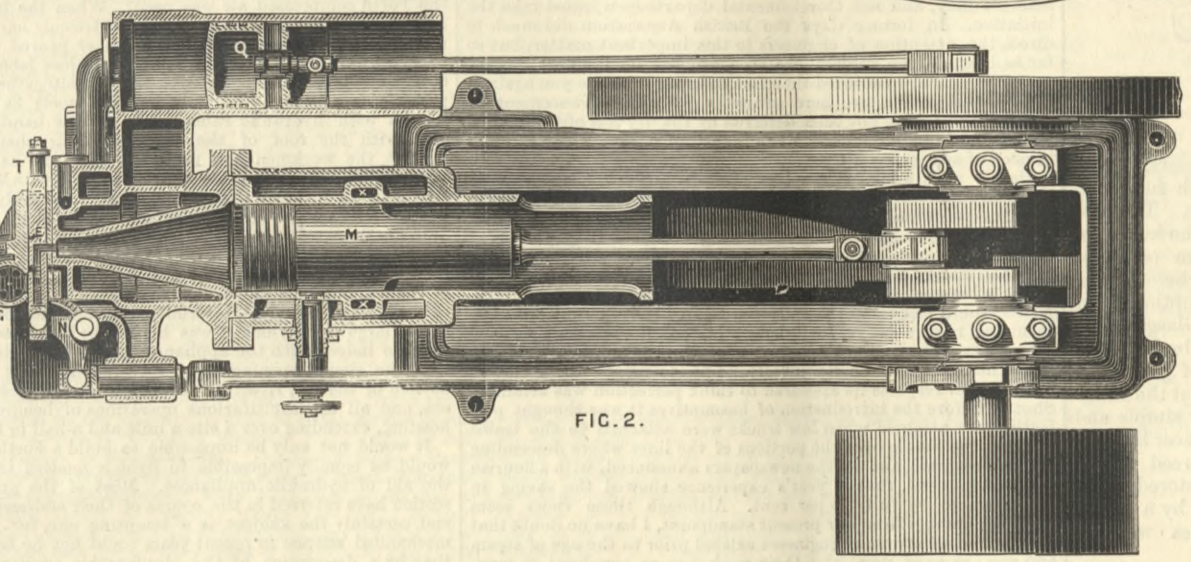
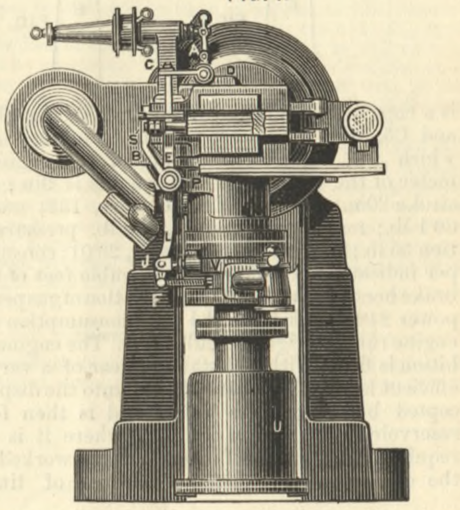


FIG. 2.

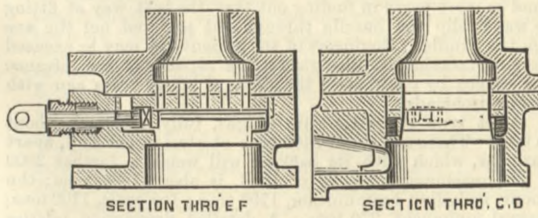
FIG. 4.



GAS ENGINES AT THE INVENTIONS EXHIBITION.

No. III.

In our impression of the 7th August we illustrated the new gas engine of the British Gas Engine Company. By the accompanying engravings we illustrate another type of engine, namely, that known as the Clerk engine, made by Messrs. L. Sterne and Co. Modern engines may be said to consist mainly of three types, as far as principle is concerned, namely :—(1) An engine drawing into its cylinder gas and air at atmospheric pressure for a portion of its stroke, cutting off communication with the outer atmosphere, and immediately igniting the mixture, the



SECTION THRO' E F SECTION THRO'. C D

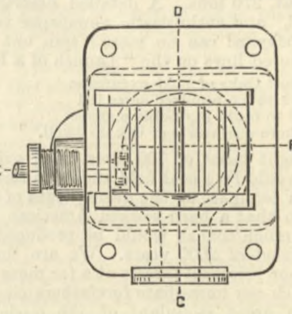


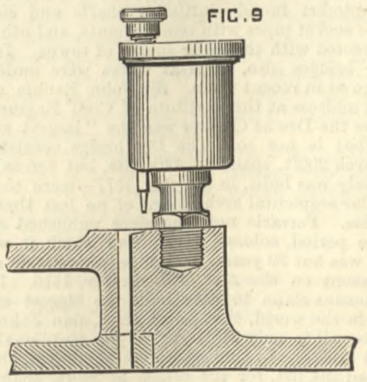
FIG 5

piston being pushed forward by the pressure of the ignited gases during the remainder of its stroke. The in-stroke then discharges the products of combustion. (2) An engine in which a mixture of gas and air is drawn into a pump, and is discharged by the return stroke into a reservoir in a state of compression. From the reservoir the mixture enters into a cylinder, being ignited as it enters, without rise in pressure, but simply increased in volume, and following the piston as it moves forward, the return stroke discharges the products of combustion. (3) An engine in which a mixture of gas and air is compressed or introduced under compression into a cylinder, or space at the end of a cylinder, and then ignited while the volume remains constant and the pressure rises. Under this pressure the piston moves forward, and the return stroke discharges the exhaust.

The first of these is represented by the Lenoir engine, the second by the Atkinson engine of the British Gas Engine Company, and the third chiefly by the Otto and by the Clerk engine. The last mentioned we now illustrate with the recent improvement, consisting of Garrett's governor gear. Our engravings also show the Clerk engine as hitherto made, but with the Garrett governor gear attached, showing that it may be readily applied to all the existing engines. The engine is sufficiently well known to make a minute description unnecessary. From the engravings—Figs. 2, 3, and 4—it will be seen that the engine is provided with two cylinders, one of which, the displacer cylinder or pump, is fitted with a piston Q, Fig. 2, and the other, the motor cylinder, having a piston M. The engine we illustrate is nominally of 6-horse power.

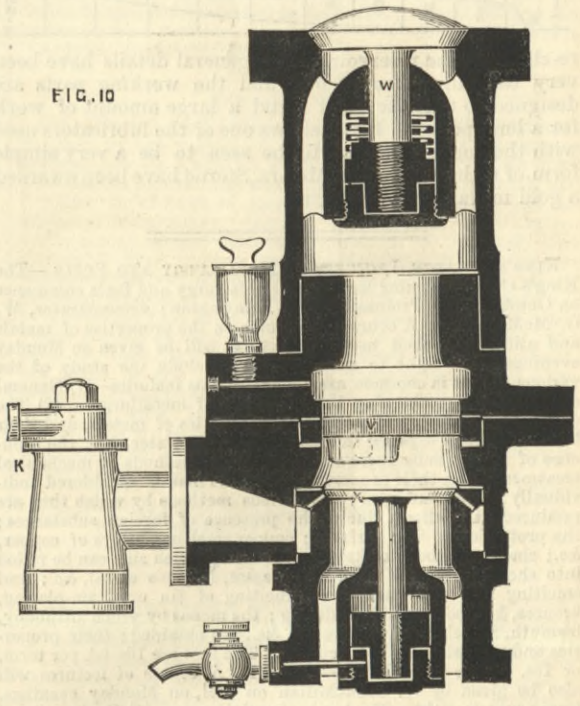
It has a motor cylinder, 7in. diameter, 12in. stroke, and a displacer cylinder, also 7in. diameter, 12in. stroke. The

FIG. 9



motor cylinder consists of the cylinder proper and a cone-shaped chamber. The admission of the mixture of gas and air to it is by means of a valve below the small end of the cone, and the products of combustion exhaust from the opposite end of the cylinder proper, through the passages X X and pipe Z. The displacer draws in a uniform mixture of gas and air through an automatic valve X, placed below the upper lift valve W, controlling the admission of mixture to the cylinder. These valves are seen at Figs. 1 and 10. The engine is governed by cutting out ignitions without waste of gas, as will be explained. The cycle of the engine, igniting the charge at each stroke is as follows:—The displacer piston, which leads the motor by half a revolution, draws in a charge of gas and air through the lower lift valve X, and the grid governor valve V, seen at Figs. 1, 5, and 10, thence through the inclined pipe seen at Figs. 3 and 4, into the displacer cylinder, gas entering through the cock K. On the return stroke of the displacer piston, the lower lift valve closes and the upper lift valve W opens automatically, allowing the charge to pass into the cylinder. The air enters at the box V, seen at Figs. 1, 3, and 4. The piston being at the outer end of its stroke, the volume remaining in the cylinder when the upper lift valve lifts is expelled through the exhaust ports X X. The motor piston now returns and compresses the charge into a cone-shaped chamber, and is ignited by means of the ignition port T in the slide E, Fig. 2, at the back of the engine; the pressure thereupon rises, and the

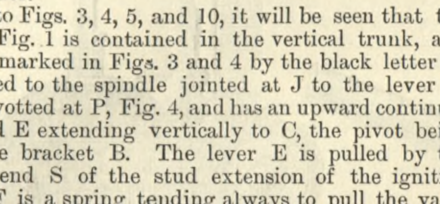
FIG. 10



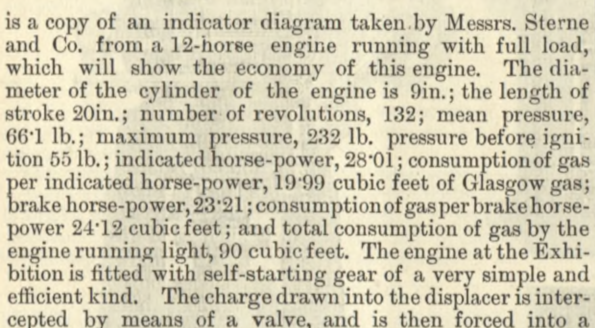
piston moves forward to perform work. Formerly the valves were arranged so that air and gas were first drawn in by the displacer cylinder and air alone towards the end of its stroke, this air alone, or rather only imperfectly mixed with the gas, acting as a scavenging charge during the first part of the return stroke of the displacer piston. This system of expelling the products of combustion by means of a partial charge of pure air has, however, now been abandoned. It is found in practice that the charge from the displacer pushes before it the whole of the products of combustion of the previous charge, this effect being helped by the hot walls of the cylinder. It is found that if the ignition be rapid, and the whole charge completely ignited before the piston has made one-tenth of its stroke, there is no risk of back ignitions taking place when the combustible mixture enters the motor cylinder. The governing is now effected by the gear already referred to, comprising a grid slide valve—see Figs. 1, 5, and 10—placed at V above the lower lift valve. It is so arranged that it is closed by the ignition slide E, Figs. 2, 3, and 4, at each revolution of engine, when the displacer is nearly at the end of its full instroke, and is retained in this position by the governor catch C if the engine exceeds its normal speed. The displacer does not take in any charge when the governor valve is closed, and consequently no charge goes into the motor cylinder.

Turning to Figs. 3, 4, 5, and 10, it will be seen that the valve V in Fig. 1 is contained in the vertical trunk, and its place is marked in Figs. 3 and 4 by the black letter V. It is attached to the spindle jointed at J to the lever L, which is pivotted at P, Fig. 4, and has an upward continuation marked E extending vertically to C, the pivot being fixed in the bracket B. The lever E is pulled by the adjustable end S of the stud extension of the ignition slide. At F is a spring tending always to pull the valve V open. When the lever B is pulled by the projection S, the lever E at C moves in the direction towards the letter D. In this position the valve V is closed, and if the engine is running too fast the governor drops the catch piece at C, Fig. 6, and prevents the return of the lever. The next stroke is therefore made without any gas. In Figs. 1 and 3 the governor is vertical as now made. Fig. 4 shows the horizontal governor as formerly made, and Fig. 7 the governor catch to a larger scale. The former is the more simple and avoids the arrangement of pivotted pawl shown at A, Fig. 4.

By this system of governing there is no loss, the amount of gas used being proportional to the work done. Fig. 8



is a copy of an indicator diagram taken by Messrs. Sterne and Co. from a 12-horse engine running with full load, which will show the economy of this engine. The diameter of the cylinder of the engine is 9in.; the length of stroke 20in.; number of revolutions, 132; mean pressure, 66·1 lb.; maximum pressure, 232 lb. pressure before ignition 55 lb.; indicated horse-power, 28·01; consumption of gas per indicated horse-power, 19·99 cubic feet of Glasgow gas; brake horse-power, 23·21; consumption of gas per brake horse-power 24·12 cubic feet; and total consumption of gas by the engine running light, 90 cubic feet. The engine at the Exhibition is fitted with self-starting gear of a very simple and efficient kind. The charge drawn into the displacer is intercepted by means of a valve, and is then forced into a reservoir to a pressure of 60 lb., where it is stored until required. By means of a small valve worked by a lever, the engine can be started a number of times without



re-charging the reservoir. The general details have been very carefully thought out, and the working parts are designed so that they will stand a large amount of work for a long period. Fig. 9 shows one of the lubricators used with the engine, which will be seen to be a very simple form of sight lubricator. Messrs. Sterne have been awarded a gold medal for their engine.

King's College, Lectures on Metallurgy and Fuels.—The King's College evening lectures on metallurgy and fuels commence on October 5th. Professor, A. K. Huntington; demonstrator, W. G. McMillan. I. A course of lectures on the properties of metals and alloys, and their uses in the arts, will be given on Monday evenings, from eight to nine, and will include the study of the various metals in common use. The syllabus includes—(1) General considerations concerning the principles of metallurgy. (2) The chemical, physical, and mechanical properties of metals, and their behaviour when exposed to the action of air, water, &c.; the influence of foreign substances and of different methods of mechanical treatment upon their properties. (3) The metals considered individually:—Iron and steel; the various methods by which they are produced; the effects due to the presence of foreign substances; the protection of iron surfaces; copper smelting, alloys of copper, &c.; zinc ores; their treatment; means by which zinc can be rolled into sheets; alloys of zinc, *i.e.*, brasses, Muntz's metal, &c.; lead smelting and desilverisation; smelting of tin ores, tin-plating, bronzes, &c.; solders and soldering; the means by which antimony, bismuth, nickel, cobalt, mercury, &c., are obtained; their properties and uses will also be discussed. The fees are 10s. 6d. per term, or 18s. 6d. for the winter session. II. A course of lectures will also be given by W. G. McMillan on fuel, on Monday evenings, from seven to eight. The heads of syllabus are—(1) Heat; general considerations. (2) Combustion. (3) Calorific Power and Intensity. (4) Wood as a fuel. (5) Charcoal. (6) Transition of Cellulose into peat, lignite, and coals. (7) Peat. (8) Lignites, and Bituminous and Anthracitic Coals. (9) Coke. (10) Patent Fuels; petroleum; other minor fuels. (11) Gaseous Fuels; coal, water, producer, blast furnace, and natural gases. (12) Regenerative Systems for reverberatory and blast furnaces. (13) Calorimetry, Pyrometry, Analysis. (14) Arrangements of Furnaces for various purposes. III. A class of practical metallurgy will be held on Fridays, from 7 to 9 p.m., in the Metallurgical Laboratories, to enable students to become practically acquainted with the properties of metals, and the general methods of assaying and mechanical testing, &c.

BRITISH ASSOCIATION AT ABERDEEN.

The following is the conclusion of the address of Mr. B. Baker, president of the Mechanical Section:—

Although, as already stated, many more experiments are required before universally acceptable rules can be laid down, I have thoroughly convinced myself that where stresses of varying intensity occur, tension and compression members should be treated on an entirely different basis. If, in the case of a tension member, the sectional area be increased 50 per cent. because the stress, instead of being constant, ranges from *nil* to the maximum, then I think 20 per cent. increase would be a liberal allowance in the case of a compression member. I have also satisfied myself that if a metallic railway bridge is to be built at a minimum first cost, and be free from all future charges for structural maintenance, it is essential to vary the working stress upon the metal within very wide limits, regard being had, not merely to the effect of intermittent stresses, but also to the relative limits of elasticity in tension and compression members even under a steady load. Why an originally strong and ductile metal should become weak and brittle under the frequent repetition of a moderate stress has not yet been explained. Lord Bacon touched upon the subject two or three centuries ago, but you may consider his explanation not wholly satisfactory. He said, "Of bodies some are fragile and some are tough and not fragile. Of fragility the cause is an impotency to be extended, and the cause of this inaptness is the small quantity of spirits." I am sorry to have no better explanation to offer, but whatever may be the immediate cause of fragility, no doubt exists that it is induced in metals by frequent bendings such as a railway bridge undergoes. This fact, however, is not recognised in our Board of Trade regulations, which remain as they were in the dark ages, as do those of the Ministry of Public Works in France and other countries. With us it is simply provided that the stress on an iron bridge must not exceed 5 tons per square inch on the effective section of the metal. In France it is still worse, as the limiting stress of rather under 4 tons per square inch is estimated upon the gross section, regardless of the extent to which the plates may be perforated by rivet holes. In neither case is any regard had in the rules to intermittent stresses or the flexure of compression members. In Austria the regulations make a small provision for these elements, and American specifications make a large one, the limiting stresses, instead of being constant at 5 tons as with us, ranging from about 2½ tons to 6¾ tons per square inch, according to circumstances. It is hardly necessary that I should say more to justify my statement that, as regards the admissible intensity of stress on metallic bridges, absolute chaos prevails. Engineers must remember that if satisfactory rules are to be framed, they, and not Governmental departments, must take the initiative. In former days the British Association did much to direct the attention of engineers to this important matter, but so far as I know, the subject has been dropped for the past twenty years, and I have ventured therefore to bring it before you again in some detail. We are here avowedly for the advancement of science, and I have not been deterred by the dryness of the subject from soliciting your attention to a branch of science which is sadly in need of advancement.

Had I been addressing a less scientific audience I might have been tempted rather to boast of the achievements of engineers than to point out their shortcomings. The progress in many branches of mechanical science during the past fifty years has exceeded the anticipation of the most far-seeing. Fifty years ago the chairman of the Stockton and Darlington Railway, when asked by a Parliamentary committee if he thought any further improvements would be possible on railways, replied that he understood in future all new railways would have a high earthwork bank on each side to prevent engines toppling over the embankments, and to arrest hot ashes, which continually set fire to neighbouring stacks, but in other respects he appeared to think perfection was attained. Shortly before the introduction of locomotives it was thought perfection was attained when low trucks were attached to the trains to carry the horses over the portions of the lines where descending grades prevailed, and all the newspapers announced, with a flourish of the trumpets, that a year's experience showed the saving in horseflesh to be fully 33 per cent. Although these views seem childlike enough from our present standpoint, I have no doubt that as able and enterprising engineers existed prior to the age of steam and steel as exist now, and their work was as beneficial to mankind, though different in direction. In the important matter of water supply to towns, indeed, I doubt whether, having reference to facility of execution, even greater works were not done 2000 years ago than now. Herodotus speaks of a tunnel 8ft. square, and nearly a mile long, driven through a mountain in order to supply the City of Samos with water, and his statement, though long doubted, was verified in 1882 through the abbot of a neighbouring cloister accidentally unearthing some stone slabs. The German Archæological Society sent out Ernst Fabricius to make a complete survey of the work, and the record reads like that of a modern engineering undertaking. Thus, from a covered reservoir in the hills proceeded an arched conduit about 1000 yards long, partly driven as a tunnel and partly executed on the "cut and cover" system adopted on the London underground railway. The tunnel proper, more than 1100 yards in length, was hewn by hammer and chisel through the solid limestone rock. It was driven from the two ends like the great Alpine tunnels, without intermediate shafts, and the engineers of 2400 years ago might well be congratulated for getting only some dozen feet out of level and little more out of line. From the lower end of the tunnel branches were constructed to supply the city mains and fountains, and the explorers found ventilating shafts and side entrances, earthenware socket pipes with cement joints, and other interesting details connected with the water supply of towns. In the matter of masonry bridges also, as great works were undertaken some centuries ago as in recent times. Sir John Rennie stated, in his presidential address at the Institute of Civil Engineers, that the bridge across the Dee at Chester was the "largest stone arch on record." That is not so. The Dee bridge consists of a single segmental arch 200ft. span and 42ft. rise, but across the Adda in Northern Italy was built, in the year 1377—more than 500 years ago—a similar segmental arch bridge of no less than 237ft. span and 68ft. rise. Ferrario not long since published an account of this, for the period, colossal work, from which it would appear that its life was but 39 years, the bridge having been destroyed for military reasons on the 21st of December, 1416. I believe our American cousins claim to have built the biggest existing stone arch bridge in the world, that across the Cabin Johns Creek, but the span after all is only 215ft., or 10 per cent. smaller than the 500-year old bridge. In timber bridges, doubtless, the Americans will ever head the list, for the bridge of 340ft. span built across the Schuylkill three-quarters of a century ago will probably never be surpassed. Our ancestors were splendid workers in stone and timber, and if they had been in possession of an unlimited supply of iron and steel, I fear there would have been little left for modern bridge builders to originate.

The labours of the present generation of engineers are lightened beyond all estimate by labour-saving appliances. To prove how much the world is indebted to students of this branch of mechanical science, and how rapid is the development of a really good mechanical notion, it is only necessary to refer to the numerous hydraulic appliances of the kind first introduced forty years ago by a distinguished past-president, Sir W. G. Armstrong. Addressing you in 1854, Sir William Armstrong explained that the object he had in view from the first was "to provide, in substitution of manual labour, a method of working a multiplicity of machines, intermittent in their action and extending over a large area, by means of transmitted power produced by a steam engine and accumulated at one central point." The number of cases in which this method of working is a desideratum, or even indispensable, would appear to be limitless. I should be sorry indeed to have anything to do with building the Forth Bridge if hydraulic appliances were not at hand to do a giant's work. Let me shortly describe to you what we are doing there at the present time. More than 42,000 tons of steel plates and bars have to be bent, planed, drilled, and rivetted together before or after erection, and hydraulic appliances are used throughout. The plates are handled in the shops by numerous little hydraulic cranes of special design, without any complication of multiplying sheaves, the whole arm being raised with the load by a 4in. direct-acting ram of 6ft. stroke. A total length of no less than sixty miles of steel plates, ranging in thickness from 1¼in. to ⅜in., have to be bent to radii of from 6ft. to 9in., which is done in heavy cast iron dies squeezed together by four rams of 24in. in diameter, and the same stroke. With the ordinary working pressure of 1000 lb. per square inch, the power of the press is thus about 1750 tons. Some 3000 pieces shaped like the lid of a box, 15in. by 12in. wide, with a 3in. deep rim all round, were required to be made of ½in. steel plate, and this was easily effected in two heats by a couple of strokes of a 14in. ram. In numberless other instances steady hydraulic pressure has been substituted by Mr. Arrol, our able contractor, for the usual cutting and welding under the blacksmith's hammer. Hydraulic appliances are also an indispensable part of the scheme for erecting the great 1700ft. spans. Massive girders will be put together at a low level, and be hoisted as high as the top of St. Paul's Cathedral by hydraulic power. Continuous girders, nearly a third of a mile in length, will be similarly raised. Not only the girders, but workmen, their sheds, cranes, and appliances, will be carried up steadily and imperceptibly as the work of erection proceeds, on platforms weighing in some instances more than 1000 tons. It is hardly necessary to say that every rivet in the bridge will be closed up by hydraulic power, the machines being in many instances of novel design, specially adapted to the work. Thus the bed-plates, which in ordinary bridges are simple castings, in the Forth Bridge are necessarily built up of numerous steel plates, the size of each bed-plate being 37ft. long by 17ft. 6in. wide. To grip together the forty-seven separate plates into a solid mass 3800 rivets 1⅛in. in diameter, with countersunk heads on both sides, are required, and remembering that the least dimension of the bed-plate is 17ft. 6in., it will be seen the ordinary "gap" rivetter would not be applicable. A special machine was therefore designed by Mr. Arrol, consisting of a pair of girders and a pair of rams, between which the bed-plate to be rivetted together lies. A double ram machine had for like reasons to be devised for rivetting up the great tubular struts of the bridge. Not merely in the superstructure, but in the construction of the foundations were hydraulic appliances of a novel character indispensable at the Forth Bridge. Huge wrought iron caissons or cylinders, 70ft. diameter and 72ft. high, were taken up and set down as readily as a man would handle a bucket. In sinking these caissons through the mud and clay of the Forth compressed air was used. When the boulder clay was reached the labour of excavating the extremely hard and tenacious material in the compressed air chamber proved too exhausting, pickaxes were of little avail, and the Italian labourers who were chiefly employed lost heart over the job altogether. But a giant power was at hand and only required tools fit for the work. Spades with hydraulic rams in the hollow handles were made, and, with the roof of the compressed air chamber to thrust against, the workmen had merely to hold the handle vertically, turn a little tap, and down went the spade with a force of three tons into the hitherto impracticable clay as sweetly as a knife into butter. Probably when addressing you thirty years ago, Sir William Armstrong never anticipated that a number of hydraulic spades would be digging away in an electrically-lighted chamber or diving bell 70ft. diameter and 7ft. high, 90ft. below the waves of the sea, but still the spades come strictly within the definition of the class of machines, intermittent in their action and extending over a large area, which it was his aim to introduce. It would be possible indeed with the appliances at the Forth Bridge to arrange that the simple opening of a valve should start digging at the bottom of the sea, rivetting at a height of nearly 400ft. above the sea, and all the multifarious operations of bending, forging, and hoisting, extending over a site a mile and a-half in length.

It would not only be impossible to build a Forth Bridge, but it would be equally impossible to fight a modern ironclad without the aid of hydraulic appliances. Most of the presidents of this section have referred in the course of their addresses to our Navy, and certainly the subject is a tempting one, for the progress of mechanical science in recent years could not be better illustrated than by a description of the innumerable appliances which go to the making and working of a modern ironclad. Let me quote a single passage from a pamphlet by a naval officer, which caused a great stir a few years before the Crimean War, that I may recall to your minds what was the speed and what the armament of our fleet at that comparatively recent period:—"Conceive," said Captain Plunkett, R.N., "a British and French fleet issuing simultaneously from Spithead and Cherbourg; seven hours' steaming at the rate of six miles an hour will bring them together. A single glance at the heavy and well-appointed tiers of a line-of-battle ship guns will satisfy anyone that they are no toys to be placed in the hands of novices. Formidable batteries of the heaviest ordnance are there—not a gun under a 32-pounder, and many 68-pounder shell guns." In little more than a quarter of a century engineers have changed all that and advanced to 20-knot vessels and 120-ton guns. Archæologists tell us that our predecessors in mechanical science, of the Stone Age, were apparently a thousand or more years in finding out that the best way of fitting an axe was to slip the handle through the axe and not the axe through the handle. Engineers of the present day may be excused therefore for occasionally illustrating the rapidity of the advance of their science by contrasting the ships of thirty years ago with our modern ironclads.

The latest type of battle ship weighs, fully equipped, about 10,000 tons. There are about 3400 tons of steel in her hull, apart from armour, which with its backing will weigh a further 2800 tons. The machinery, largely of steel, is about 1400 tons; the armament, including ammunition, 1100 tons; the coals, 1100 tons; and general equipment, 270 tons. A detailed description bristles with the word "steel," and enthusiastic newspaper reporters sent down to Chatham Dockyard can no more "spin out their copy" with Cowper's oft quoted lines on the "Launch of a First-Rate"—

Giant Oaks of bold expansion
O'er seven hundred acres fell
All to build thy noble mansion
Where our hearts of oak do dwell.

A latter-day poet might boast of 700 acres being exhausted by a single vessel, but it would be a coal field and not a forest. Accepting Professor Phillips' estimate of the average rate of formation of coal, it may be shown that a hard-worked American liner during her lifetime burns as much coal as would be produced on the area of 700 acres in a period of 2000 years. We are thus with our steel ships using up our primeval forests at a far more extravagant rate than that at which our immediate forefathers cleared the oak forests. Coal is the great stimulant of the modern engineer. Pope Pius the Second has left on record an expression of the astonishment he felt when visiting Scotland, in the fifteenth century, on seeing poor people in rags, begging at church doors, and receiving for alms pieces of black stone with which they went away contented. To such early familiarity with coal may, however, be due the fact that Scotland has ever led the way in the development of the steam engine, and that at the date of the Battle of Waterloo she had built and registered seven steam vessels, whilst England could boast of none. Probably none but a poet or a painter would wish for a return to our old oak sailing ships. Some few people still entertain the illusion that the picturesque old tubs were better sea boats than our razor-ended steamers, but speaking of them in 1846, Admiral Napier said, "The ships look very charmingly in harbour, but to judge of them properly you should see them in a gale of wind, when it would be found they would roll 45 deg. leeward and 43 deg. windward." Even our first ironclads were not so bad as that, for although according to the *Times*, when the squadron was on trial in the Bay of Biscay, the ships rocked wildly to the rising swell and the sea broke in great hills of surf, yet the maximum roll signalled by the worst roller of the lot—the Lord Warden—was but 35 deg. leeward and 27 deg. windward, a total range of 62 deg., as compared with 88 deg. in the old line-of battle ships. We have heard much about the state of the Navy during the past twelve months. A dip into the publications of the British Association—which in this, as in other respects, afford a fair indication of what is uppermost in people's minds—will show that similar discussions have recurred periodically, at any rate since 1830. If we consult Hansard, as I had occasion to do recently, we find the same remark applies to periods long antecedent to 1830. It amounts almost to a religious conviction in the mind of a Briton that Providence will not be on his side unless his fleet is at least equal to that of France and Russia united. What would be said now of a minister who met an attack on the administration of the Navy by demonstrating that we had half as many line-of-battle ships as Russia; and yet that was literally done less than fifty years ago. Speaking in the House of Commons, on March 4th, 1839, the Secretary of the Admiralty said:—"For the last six months unceasing attacks have been made upon our naval administration, describing our Navy as in a state of the utmost decrepitude, and Tory papers say that shameful reductions have been made in the Navy by the present Government. It will be a consolation to my honourable friends to be assured that we have for years lived unharmed through dangers as great as that to which we are now exposed. In 1817 we had fifteen sail of the line in commission, and Russia had thirty; in 1823 we had twelve, and Russia thirty-seven; in 1832 we had eleven, and Russia thirty-six; and now we have twenty, and the Russians forty-three, having raised our ships to nearly half the number of those of Russia." Now, as to our guns. The past twelve months is by no means the first occasion on which the armament of our Navy has been attacked. Three years subsequent to the speech of the Secretary of the Admiralty just referred to, Sir Charles Napier made a statement from his place in Parliament of so extraordinary a character that I make no apology for quoting his exact words, as a reminder of the past and a warning for the future:—"At the end of the last war the guns were in such a bad state that when fired they would scarcely hit an enemy, and during the latter period of the American war a secret order was issued that British ships of war should not engage American frigates, because the former were in such an inefficient state." As for himself, said the plain-spoken old admiral, when he got the order he put it in the "only place fit to receive it—the quarter-galley." Happily, from our insular position, the change which the progress of mechanical science has wrought in military operations has not been brought home to the people of this country in the same vivid manner that it has to the people of the continents of Europe and America. In the American war, the Franco-German war, and the Russo-Turkish war, the construction and equipment of railway works by engineers was an essential part of all great movements. The Russians, in 1877, constructed a railway from Bender to Galatz, 189 miles in length, in fifty-eight working days, or at the rate of more than three miles a day. Altogether, in the three latter months of that year, they laid out and built about 240 miles of railway, and purchased and stocked the lines with 110 locomotives and 2200 wagons. They also built numerous trestle bridges, together with an opening bridge, and a ferry across the Danube. We have had recent experiences of the slowness of primitive modes of transport in the tedious advance of Lord Wolseley's handful of men in whale-boats up the Nile. It was the intention of the late Khedive, partly from military and partly from commercial considerations, to construct a railway exactly on the line of advance subsequently followed by Wolseley. My partner, Mr. Fowler, had the railway set out in 1873, and the works were shortly after commenced. The total length was 550 miles, and the estimated cost, including rolling stock and repairing shops, was £4,000,000. Owing to financial difficulties the works were abandoned, but the sixty-four miles constructed by Mr. Fowler, and the recent extensions of the same by the military, proved of great service to the expedition, even some of the steam launches being taken by railway to save delays at the cataracts. During the siege of Paris, the German forces were dependent upon supplies drawn from their base, and the army requirements were fully met by one line of railway running twelve to fourteen trains per day. Military authorities state that a train load of about 250 tons is equal to two days' rations and corn for an army corps of 37,000 men and 10,000 horses. The military operations in Egypt have proved that even in the heart of Africa, railways, steamboats, electric lights, machine guns, and other offspring of mechanical science are essential ingredients of success.

Members of this section who visited the United States last year not for the first time, could hardly have failed to notice that American and European engineering practice are gradually presenting fewer points of difference. Early American iron railway bridges were little more than the ordinary type of timber bridge done into iron, and the characteristic features therefore were great depth of truss, forged links, pins, screw bolts, round or rectangular struts, cast iron junction pieces, and in brief, an assemblage of a number of independent members more or less securely bolted together, and not as in European bridges, a solidly rivetted mass of plates and angle bars. At the present moment the typical American bridge is distinctly derived from the grafting of German practice on the original parent stock. Pin connections are still generally used in bridges of any size, but the top members and connections are more European than American in construction, whilst for girders of moderate span, such as those on the many miles of elevated railway in New York, rivetted girders of purely European type are admittedly the cheapest and most durable. From my conversations with leading American bridge builders, I am satisfied that their future practice and our own will approach still more nearly. We should never think of building another Victoria tubular bridge across the St. Lawrence, or repeat the design of the fallen Tay Bridge, nor would they again imitate in iron an old timber bridge, or repeat the design of the fallen Ashtabula Bridge. In one respect the practice in America tends to the production of better and cheaper bridges than does our own practice, and it is this:—Each of the great bridge-building firms adopts by preference a particular type design, and the works are laid out to produce bridges of this kind. It is an old adage that practice makes perfect, and by adhering to one type and not vaguely wandering over the whole field of design, details are perfected, and a really good bridge is the result. Engineers in America, therefore, need only specify the span of their bridge, and the rolling load to be provided for, with certain limiting stresses, and they can make sure of obtaining a number of tenders from different makers of bridges varying somewhat in design, but complying with all the requirements. With us, on the other hand, it is too often the privilege of a pupil to try his 'prentice hand on the design for a bridge, and it is no wonder, therefore, that many curious bits of detail meet the eye of an observant foreigner inspecting our railways. The magnificent steel wire rope suspension bridge of 1600ft. span, built by Roebling across the East River at New York, well marks the advanced state of mechanical science in America as regards bridge building. It is worthy of note that at the second meeting of the British Association, held so long back as 1832, there was a discussion on suspension bridges, and the author entreated the attention of the scientific world, and particularly of civil engineers, to the serious consideration of the question, How far ought iron to be hereafter used for suspension bridges, since a steel bridge of equal strength and superior durability could be built at much less cost? "I earnestly call upon the ironmasters of the United Kingdom," said he, "to lose no time in endeavouring to solve this question." In this, as in many other engineering matters, America has given us a lead. America is, indeed, the paradise of mechanics. When the British Association was inaugurated years ago, there was, I believe, no intention to have a section for the discussion of mechanical science. Possibly it may have been considered too mean a branch. Even the usually generous Shakespeare speaks contemptuously of "mechanic slaves, with greasy aprons, rules, and hammers;" and our old friend Dr. Johnson's definition of "mechanical" is "mean, servile." We have lived down this feeling of contempt, and the world admits that the "greasy apron" is as honourable a badge as the priest's cassock or the warrior's coat of mail, and has played as important a part in the great work of civilising humanity, and turning bloodthirsty savages into law-abiding citizens.

As I have had occasion to refer to Canada and America in the course of my remarks, I cannot refrain from expressing the high appreciation which I am sure every member of this section entertains of the cordiality and warmth of our reception on the other side of the Atlantic last year. Such incidents make us forget that differences have ever existed between the two countries. I was amused the other day on reading in Dr. Doran's "Annals of the Stage," that, in the year 1777, the theatrical company from Edinburgh was captured on its voyage to Aberdeen by an American privateer, and taken off heaven knows where, for it did not turn up again. This, you will say, was a long time ago; but if you glance through the speeches of our present gracious Sovereign, you will find one in which her Majesty speaks with "deep concern" of insurrection in Lower Canada, and of hostile incursions into Upper Canada by certain "lawless inhabitants" of the United States of North America. This is strange reading after our last year's experience. Gentlemen, I may not have carried you with me in some things I have said, but I think you will all agree with me in this: That the statesman who should suffer any slight difference of opinion to develope into a serious breach between ourselves and our brethren in Canada and cousins in America, would, to quote the words of Burke, "far from being qualified to be directors of the great movements of this empire, be not fit even to turn a wheel in the machine."

LETTERS TO THE EDITOR.

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

ENGLISH AND FOREIGN STEAM ENGINES.

Sir,—I am obliged to you for the insertion of my letter in your issue of the 18th inst., which, in consequence of absence from home, I have only seen to-day. I see you question my assertion as to the bad governing of engines. My statement was that there is no engine at the Inventions Exhibition employed in turning electric light machinery that can be controlled within 5 per cent. of any agreed number of strokes. You say this is not true of the larger-sized engines. I have only to reply that my remarks apply to any size of engine at work on the electric light machinery. I will go further and say that there is not—with the exception of two makes, one of which has not received a gold medal—any engine in the Inventories, large or small, that will not vary 5 per cent. or over under varying load or varying pressure of steam. Some of them vary over 20 per cent.

If any maker questions my statement, I shall back my opinion for the benefit of any charity he names, and if he succeeds in his trial it will be a good advertisement for him.

My object in writing to you was to point out that our engines are carelessly and slovenly constructed, and it is only because the buyers and users know even less than the builders that the great faults pointed out in my first letter have not long since been remedied. Correct proportion of parts, which means evenly balanced engines, with governing so arranged as not to vary outside 1 per cent., are attainable and ought to be insisted upon by users; and if this is attained, then the object of my letter is also attained.

Observer.

Manchester, September 26th.

Sir,—I hope the discussion raised on this subject will not be allowed to drop until something is done to modify the conditions under which we in this country are compelled to produce and sell steam engines. It is not remarkable that English machinery should be bad, because we have no inducement whatever to make it good. My own opinion is that foreigners always now buy what may be called good machinery at home, while they come to England for their cheap goods. We are so handicapped by foreign tariffs that it is simply impossible for us to compete level with the engineers of France or Germany. Many will no doubt back up the assertion that the only chance we have of making a living lies in making steam engines by the hundred at the cheapest possible rates. American alarm clocks are sold retail for about 7s. 6d. each; the prime cost to the maker does not exceed one dollar. The quality of these clocks is good in its way, but they cannot compare for a moment with first-class timekeepers. The saleable English steam engine of the present day is made like the American clocks in question, and can be sold at a good profit. The production of really high-class engines is in the hands of two or three firms, and I have every reason to know that their profits are small. Even these firms are living for the most part on a past reputation, and unless they consent to move with the times, they, too, will have either to shut up their shops or become steam engine manufacturers.

One of our great difficulties is, as has been pointed out by one of your correspondents, the part played by the middleman or agent. These gentlemen constitute a powerful guild, and they take very good care to make it impossible for us to do without them; as matters now stand they absorb all the profits.

Another thing that ought to be discouraged is the giving of long credits. As much as four years is given by limited companies with more money than brains. I was told by a partner in a well-known Midland concern that his firm had £190,000 due to them on one New Year's Day, and that they were "getting rather uneasy." I do not suppose that one-half of this money has yet been paid. This is not legitimate trading, and when such companies fail, I confess I feel nothing but delight.

Not to intrude further on your space, I will stop here, but not until I have once more asked your readers who are interested in this matter to give their opinions as to the possibility of adopting a policy which may do us good.

J. D. K.

Liverpool, September 27th.

Sir,—In your issue of the 18th inst. a letter appears *re* "English and Foreign Steam Engines," signed "Observer," in which he draws attention to defective governing, and says that when expensive plants have been laid down for electric lighting with every known improvement, the whole thing is marred by an engine that cannot govern within 10 to 20 per cent., and further, he asks if there is an engine at the Inventions Exhibition that can govern within 5 per cent.? Certainly the one shown by Hick, Hargreaves, and Co., of Bolton, driving the American Court, is far within that limit, as any one may may see by examination of the Moscrop recorder driven by the engine, which gives a practically straight line; and with your permission I would call attention to a statement made last August by Mr. Druitt Halpin in the discussion that followed upon a paper by Mr. R. C. Nevile on "Private Installations of Electric Lighting," read before the Institution of Mechanical Engineers at Lincoln. Mr. Halpin said that when a constant speed was required it could be perfectly attained by mechanical means, and instanced a compound engine supplied by the makers above referred to for lighting a foreign town, in which the variation of speed caused by a reduction of the load from 200 to 100-horse power amounted to but one-third of 1 per cent., as shown by a Moscrop recorder.

Governor.

September 29th.

THE EFFICIENCY OF BOILERS

Sir,—A letter on the above subject, signed "Economist,' appeared in your valuable journal of the 24th of April last, and in common with many of your readers who, as manufacturers, have been living in hopes that some of your correspondents of "lig and leading" would have given us their views on the extraordinary statements contained therein; but with the lofty contempt born of superior knowledge, the subject has been ignored, such a trifle as a saving of 60 per cent. in coal not being worth their notice. As a manufacturer using 700 tons of coal per week, and a part owner in a colliery, I have thought it worth while to investigate the matter, and with the aid of the patent list I have managed to discover and interview the inventor, by whom I was courteously received, and who readily gave me the information I desired, the substance of which I beg permission to lay before your readers. On commencing our conversation he directed my attention to the fact well known to scientists, that of the heat produced from a given quantity of fuel not more than one-tenth part can be credited with useful work when applied to the work of the steam engine, the remaining nine-tenths being lost in some way unknown. A consideration of this fact suggested the first question, viz., what has become of this lost energy? In answer the inventor produced a sketch of a Cornish boiler set in the usual manner, which, for the purpose of illustration, was supposed to consume one ton of coals in twelve hours. Now, in order to consume this quantity of coal in this time it is necessary to supply the furnace with 1000 cubic feet of atmospheric air per minute, and as this air is supplied ordinarily by the action of a chimney draught, it follows that the same quantity of hot gases must be drawn away into the chimney in the same time, the greater part of the heat contained in these gases being wasted, and thus a very considerable part of the nine-tenths of heat lost are accounted for. Having thus, as I believe, traced the disease to its source, the next thing to do is to discover a remedy. This is accomplished by what appears at first sight to be an old-fashioned contrivance for blowing air into the furnace by means of a fan, but the inventor soon proved that there were different ways of doing this, and that it was upon one of these ways that the successful working of his apparatus depended, the principal conditions of which are (1) to supply a sufficient quantity of air to the furnace to effect the combustion of the fuel—that is, to consume the fine dust, soot, and all those carbonaceous products that go to produce the abomination called smoke; (2) by keeping the damper nearly closed the heat is retained in the flues long enough to allow of its absorption by the water in the boiler, thereby utilising the heat that would otherwise be wasted; and (3) that the apparatus shall be so constructed that the fan shall supply the largest possible volume of air with the least expenditure of power, and that the air be supplied in a steady volume without disturbance or undue force, and that the pressure be equal over the whole grate surface. As a result of these arrangements the inventor has succeeded in evaporating 17 lb. of water with 1 lb. of coal.

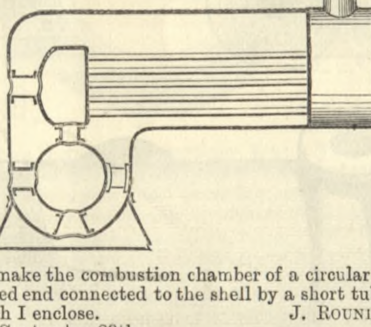
From what I have gathered I feel satisfied that we are on the eve of a great revolution in science as applied to the economical production of steam power. The apparatus can be readily applied to marine boilers, so that the saving in stowage as well as in cost of fuel will be enormous. The inventor is now working out his discovery by his own unaided efforts, and hopes soon to put it before the public in a practical form, but being an outsider he can neither get encouragement or assistance from engineers.

September 29th. W. Macdonald.

[We publish Mr. Macdonald's letter lest we should be charged with attempting to check progress. We may be excused, perhaps, if we point out that it must be an incredibly bad boiler that wastes nine-tenths of the energy developed in the furnace. Mr. Macdonald mixes up the engine and the boiler. He is no more likely to get 17 lb. of steam in return for 1 lb. of coal than he is to get twenty-five sovereigns for a £20 note.—Ed. E.]

ROUNDTHWAITE'S BOILER.

Sir,—Permit me to say that I do not now use the form of combustion chamber shown in your engraving of my boiler, 18th Sep-



tember. I make the combustion chamber of a circular form with a dished flanged end connected to the shell by a short tube, as shown by the sketch I enclose.

J. Roundthwaite.

Ardwick, September 29th.

THE BRAKE RETURNS.

Sir,—Having read some remarks made by Mr. Clement E. Stretton on the subject of the Continuous Brake Returns, and noticing how he makes an analysis of, and how, in his opinion, he considers the returns should enumerate, he mentions, firstly, "failure under cases of emergency;" secondly, "failure under ordinary circumstances;" thirdly, "cases of delay." With reference to the second clause, what is the meaning of "ordinary circumstances?" Does it mean burst hose pulling up trains on certain dangerous parts of the line when not wanted? Does it mean the extensive renewal of certain classes of brake where on certain lines it is reported that some thousands of hose have to be renewed yearly because of their being subjected to a pressure that deteriorates the material, and consequently must be a grave defect? Is the writer of this letter perfectly unprejudiced in his views in bringing forward this second clause? If he is, would it not be well if he would let the public know his interpretation of this clause? To my mind there is no limit to what this clause could be extended to, and it is a mistake to alter Board of Trade forms without having very clear and definite reason.

Henry Prince.

Herne Cottage, The Hill, Long Ditton,
Surrey, September 28th.

STRAW BURNING PORTABLE ENGINES.

Sir,—I notice Messrs. Ransomes, Head, and Jefferies' letter in your impression for September 18th, in which they say that their engines will give a horse-power for 12 lb. of straw per hour. May I be permitted to ask if this is brake horse-power or indicated horse-power, the pressure of steam, and whether the engine is or is not compound.

Roumelia.

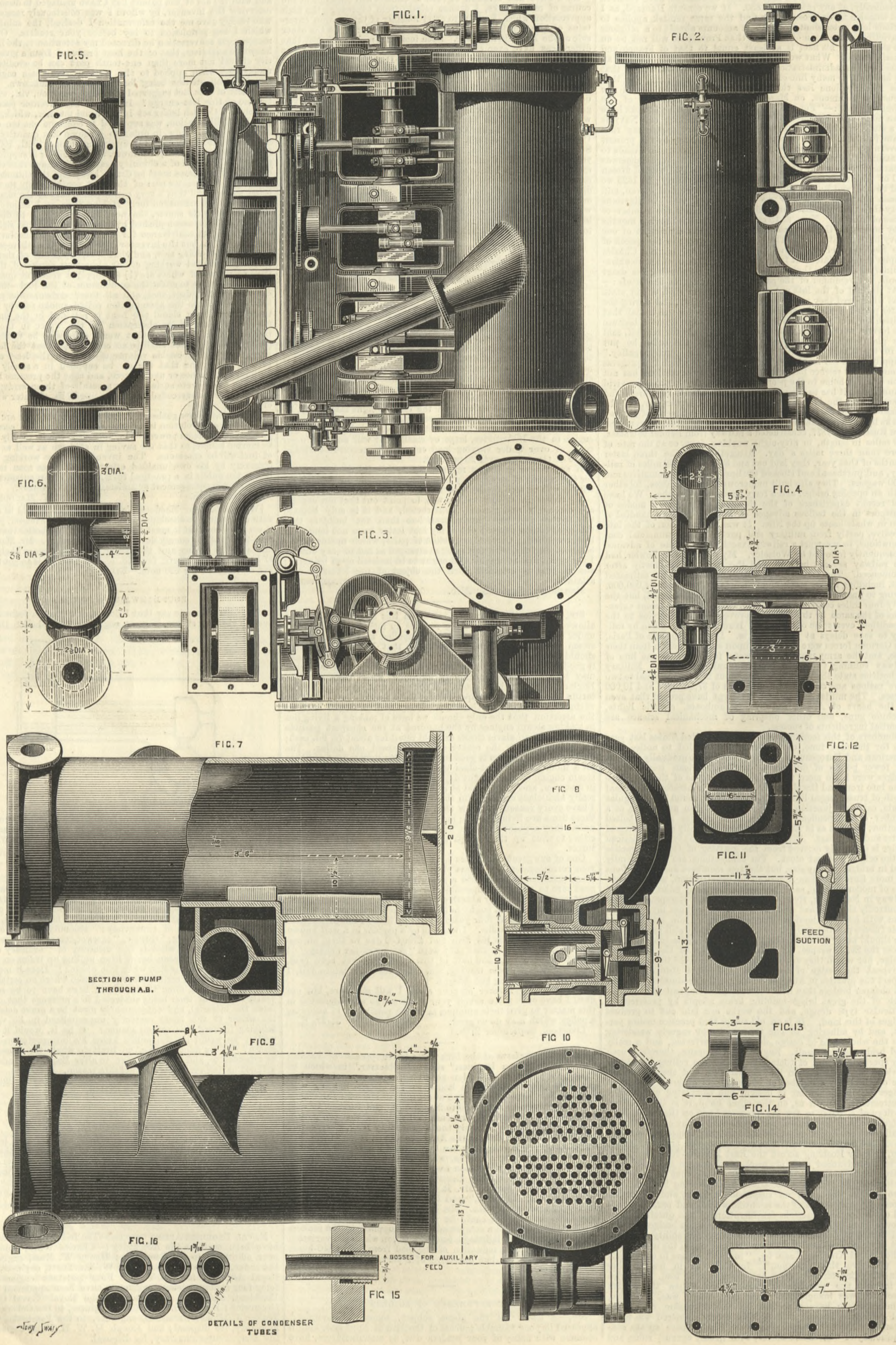
Buda Pesth, September 24th.

Naval Engineer Appointments.—The following appointment have been made at the Admiralty:—Charles Ware, chief engineer, additional to the Pembroke; Henry W. Ross, engineer, to the Indus, for the Woodcock; and William Scott, engineer, to the Royal Adelaide, for the Vivid. Four assistant engineers and forty-four acting assistant engineers have been appointed to the President, additional, for study at the Royal Naval College, Greenwich; Edward G. P. Moffatt, engineer, to the Osborne; and Walter J. Graham, assistant engineer, to the Pembroke, supernumerary, for disposal; and Joseph H. W. H. Ellis, engineer, to the Asia, as supernumerary, for disposal.

COMPOUND SURFACE CONDENSING MARINE ENGINE.

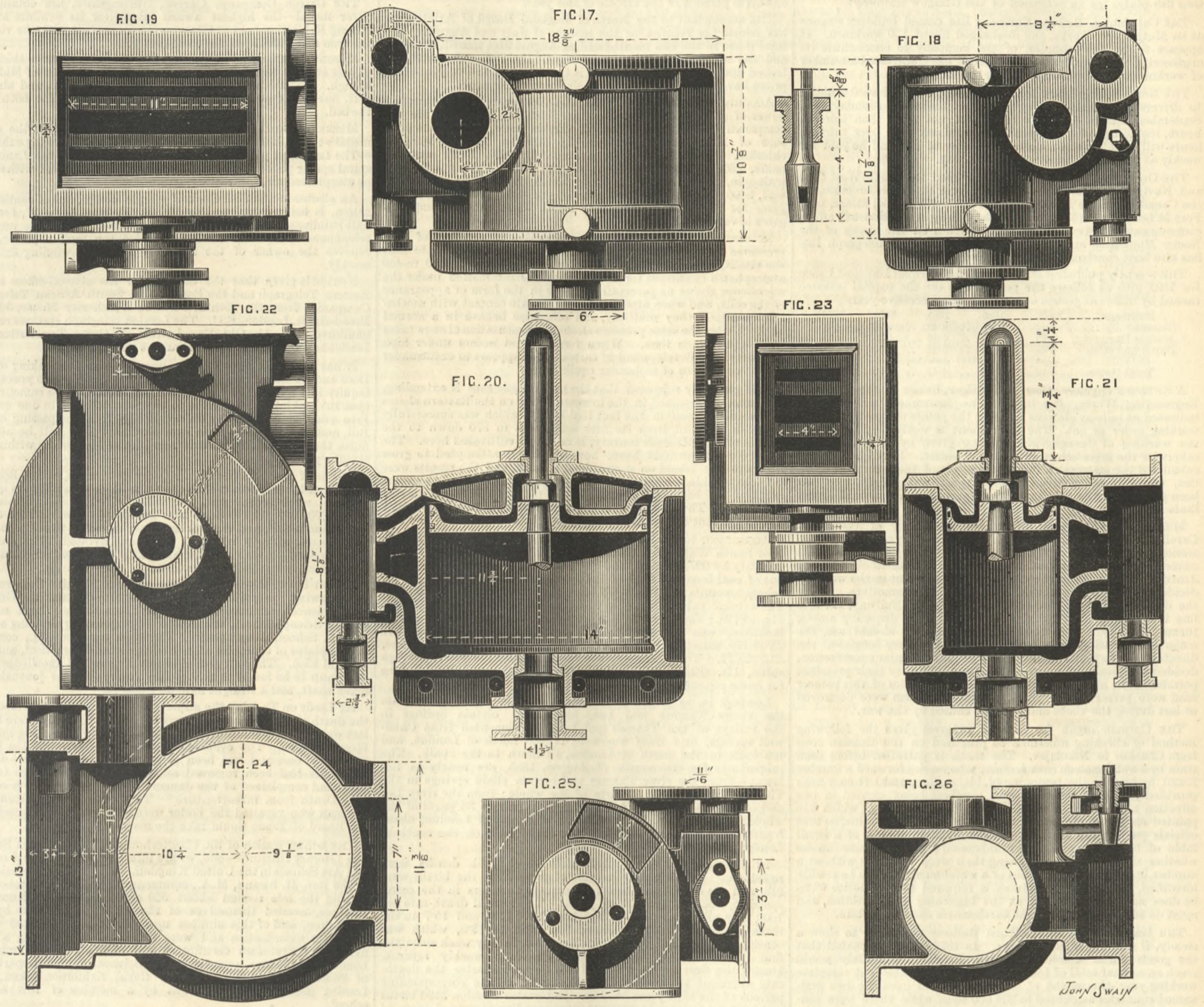
THE LONDON AND COLONIAL ENGINEERING COMPANY, LONDON, CONSTRUCTORS

(*For description see page* 261.)



COMPOUND SURFACE CONDENSING MARINE ENGINE.

THE LONDON AND COLONIAL ENGINEERING COMPANY, LONDON, CONSTRUCTORS

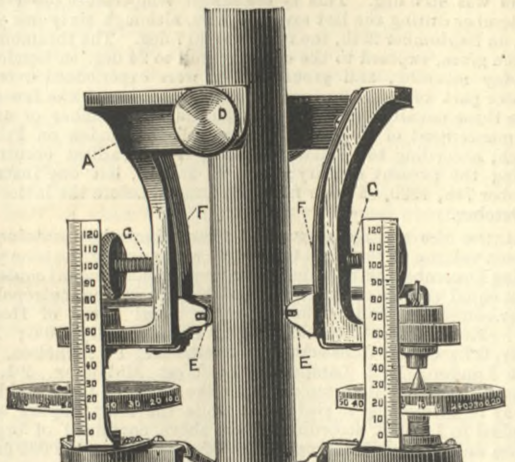


COMPOUND MARINE ENGINES.

THE engravings above and on page 260 illustrate an engine, nominally of 15-horse power, made by the London and Colonial Engineering Company, London, from the designs of Mr. G. A. Goodwin, Westminster. The engine is intended for launches, yachts, or tugs, and one is exhibited at the Inventions Exhibition. The design has been prepared with the view of obtaining extreme compactness—see Figs. 1, 2, 3, and 5—keeping the centre of gravity as low as possible, with simplicity, and effective results. A rectangular bed-plate carries the whole of the engine, and in it are cast passages connected with the circulating and air pumps, which lie between the cylinders and guides respectively, thus enabling external pipes to be dispensed with. The high and low-pressure cylinders are attached to one end of the bed, the circular guides being cast on at the other, the usual double-throw crank shaft being placed centrally between them; this enables very long return connecting rods to be used. The condenser is placed over and attached to the guides, or connected to the bed-plate by two hollow feet, and tends to balance the weight of the cylinders. The piston rods are attached to the cross-heads, which have adjustable slippers, through the intervention of strong cast steel bridles, which encircle the crank pins, but do not touch them. The cylinders—see Figs. 17 to 26—have the steam chests cast on; the piston rods are carried through the covers so as to carry the weight of the piston, and are arranged so that they and their hoods can be dispensed with, if want of space should so require it. The valve spindles and nuts are of gun-metal, and have adjustable forked ends for tightening on to the reversing link blocks. The crank shafts have double throws, are of hammered scrap iron, the jaws are slotted out of the solid, the coupling is forged on, and in some cases one set of excentrics. The bed-plates have the main bearings cast on, which are fitted with gun-metal linings, and so designed that they can be withdrawn by slightly raising the crank shaft. The connecting rods are also of forged scrap. The condensers—see Figs. 7 to 14—are horizontal, and have a large condensing surface formed by brass metal tubes secured to the brass metal tube plates by brass ferrules as and at the distances apart shown at Fig. 16; the steam is well distributed into the condensers through a bell-mouthed branch. The circulating water passes through the lower and returns through the upper tubes, and is discharged at one end at the top. The condensed steam drains into the air pumps, which are immediately below them. The reversing gear is clearly seen in Figs. 1 and 3. The feed pump—see Figs. 4 and 6—working parts are of gun-metal, the piston rods of steel, valve spindles and nuts of gun-metal; the links, joint pins, and all similar working parts are of cast steel or wrought iron case-hardened. The cylinders and steam chests are lagged with asbestos and hair felt, and covered with teak. Our engravings are so complete that further description is unnecessary. They show that the engine is well designed throughout.

MARSHALL'S TESTING MICROMETER.

THE accompanying engraving shows a micrometer for use with testing machines. It is the invention of Mr. C. A.



Marshall, of Johnstown, Pa., U.S.A. The engraving is from a photograph, and shows the apparatus in place on a 1¼in. round bar. It is in independent and rigid halves, the upper and lower frames being solid castings precisely alike, the latter receiving nuts and micrometer screws with graduated head and index scales, the upper head receiving insulated contact plugs which are readily replaceable by others suited to the length of specimen to be operated on. The gauged length when set as shown in the cut is 8in. Each frame passes on to the specimen in place by means of the opening left in one corner of the base ring of the frame. The lower half is first placed in position and fastened by the two pointed screws, C and its opposite, whose common axis is made to pass through and at right angles to axis of specimen. The axis of these screws is midway between the two micrometer screws and normal to their plane, which should also be made to pass through the axis of specimen or at least close to and parallel with it. The weight of the lower frame being now sustained by the screws the side rollers are opposing each other with the force of the double leaf springs F F on which they are mounted. These side bearings are axle bearing rollers; they are necessary to keep the alignment of the instrument, and are placed as far as may be from attachment points, so as to minimise the side pressure required for stability. As the specimen stretches, its surface passes under the rollers, causing them to revolve, and they are made as nearly frictionless as possible, so that this action may cause no disturbance of the instrument with relation to extreme points of attachment screws. They are brought to a proper bearing, and the alignment made by simply following up against the springs with the screws G G. The instrument in the form shown is intended for use with vertical specimens, hence the small level H affords a handy means of accurate alignment. The upper frame is set to distance mark on the specimen and is readily aligned by the eye, using the lower frame as a guide, and bringing the plugs opposite the micrometer screws by the same means as before. Electric connection is made by the means provided, preferably using very light copper wires, so as to be more free from accidental disturbances to the instrument. In determining the change of length of axis of specimen due to certain increments of load, each micrometer is read by electric contact to, say, the 20,000th part of an inch—graduations of head are in 10,000ths—before and after applying the increment of load; the difference of mean readings before and after is the quantity sought. The aim in designing this instrument was to insure that the readings give the true axial stretch of the specimen between definite points of attachment. The first thing, therefore, is to make the connection to specimen definite and through the axis, which is done; the next care is to eliminate all disturbances to weight or pressure upon the attaching screws, especially those due to stretching of specimen, which the lightly pressing rollers accomplish in a remarkable degree. With moderately smooth surfaces even having scale on the friction is almost inappreciable, so that the motion of the surface past the rollers has an effect upon the readings of the instrument which may be disregarded without practical error. Numerous trials with varying conditions of surface have been made to demonstrate this fact.

RAILWAY MATTERS.

THE Steel Company of Scotland has obtained the order to supply 670 tons of girder section tramway rails and 25½ tons of fish-plates, with a further optional quantity of 800 tons rails and 31 tons fish-plates for an extension of the Glasgow tramways.

THE Caledonian Railway Company has ceased building wagons at its Motherwell Works, and discharged about 150 workmen. It appears to be the intention of the company to concentrate its engineering work at Glasgow, to which it has transferred a number of workmen, and it is also removing its plant.

THE North Staffordshire Tramways Company has issued a notice to drivers and conductors to the effect that from Monday last, September 28th, a day is to consist of not more than thirteen hours, including relief for meals, &c., and any time over thirteen hours will be allowed to accrue from day to day and be paid for weekly at the rate of twelve hours to a day.

THE Governor-General of Canada opened the North-West Coal and Navigation Company's Railway from Dunmore Junction, on the Canadian Pacific Railway, to the Belly River Coal Mines, near Fort M'Leod, on the 24th inst. The railway in addition will afford communication between the cattle ranches on the slopes of the Rocky Mountains and Manitoba and the East. A telegraph line has also been constructed in connection with it.

THE recently published statistics of the German Railroad Union for 1883 give as follows the percentages on the capital invested earned by different groups of railroads for successive years:—

Railroads.	1879.	1880.	1881.	1882.	1883.
German	5·41	4·48	4·49	4·72	4·63
Austria-Hungarian	4·03	4·15	4·40	4·70	4·76
Dutch and other ..	3·46	3·83	3·82	4·53	4·90
Total Union ..	4·22	4·23	4·42	4·70	4·69

A SWEDISH engineer, Herr N. Löttiger, owner of the Elmhults Engineering Works, has invented an instrument whereby it is indicated at railway stations whether the points on the line are in working order or not. The instrument is worked by electricity, the warning of disengagements being given by means of bells; otherwise the invention is, of course, a secret. Herr Löttiger has submitted the instrument to the inspection of the railway authorities, whom it has satisfied in every particular. Permission has been given to fit the apparatus for experiments on several of the State lines.

MR. P. J. COCHRANE, Master of Machinery of the South Carolina Railway, has, the *National Car Builder* says, in his possession a piece of the first strap rail put down on the road he is connected with. That road has a claim to high distinction among American railroads, for the company were the first in the world to decide that their line should be operated by locomotives. When the directors of the Liverpool and Manchester Railway, the first line in England built for general traffic, were disputing among themselves about what form of traction they should use, the majority favouring rope traction and stationary engines, the directory of the South Carolina Railway, then under construction, decided to operate by locomotive engines, and gave their president permission to have an engine built. Many relics of this pioneer road were preserved for years, but most of them were destroyed or lost during the chaos and disorder caused by the war.

THE German organ for railroad progress gives the following method of checking milesmen as practised on the Russian road from Charkov to Nikolajev. The track is patrolled before each train by a watchman on each section, who carries forward a number found by him at the beginning of his section, and left on a hook provided for it at the end, even numbers being carried in one direction and odd ones in the other. The numbers, which are painted on metal plates, are hung in view of the trains, so that officials passing can readily see them, and by means of a small table of the positions of the numbers on any day or hour can see whether the watchmen are doing their work. A hook without a number indicates the negligence of a watchmen, who can be readily identified, since every watchman is required to give notice when he does not find a number at the beginning of his section, and must do so to avoid having the carelessness ascribed to him.

THE traffic on the St. Gothard Railway continues to show a steady, if not very rapid, increase. In 1876 it was estimated that the goods traffic between Germany, Belgium, and Italy would reach an annual total of 150,000 tons. In 1883, the first complete working year, the weight of merchandise sent from the two first-named countries amounted to 204,000 tons, while there were consigned thither from Italy 37 tons. In 1884 the traffic both ways made an aggregate of 249,000 tons. The list of articles transported from the two northern countries to the Peninsula is headed, in 1884, with hardware, 89,958 tons; next come coals, exclusive of fuel for the service of the line, 64,835 tons; while glass and earthenware figure for 6000 tons, textile fabrics for 3412, and paper for 1610. For these things Italy gave in exchange, wholly or in part, 13,125 tons of eggs, 4476 tons of flax, 1964 tons of marble, 3558 tons of fruit, 1637 tons of wine, and 316 tons of corn, and several other commodities.

THE *Chicago Railway Age* states that over 1650 trains pass over the junction of the New York Elevated Railroads at Chatham-square every twenty-four hours. No railroad in the world does an equal train business on two tracks. There is a junction in London where 2400 trains pass daily, but four tracks are provided for their accommodation. The only railroads in operation that compare with the New York Elevated Railroad system for crowded business are the London Underground Railways. The Underground Railways carry an enormous number of passengers, and the traffic has developed very rapidly. In 1879 a total of 91,420,178 persons were carried by the London Underground Railways, while in 1884 the number had increased to 114,447,514. During the corresponding five years the New York Elevated Railroads showed an increase from 46,045,181 to 96,702,620; in other words, while the Underground showed an increase of 23,027,336 in five years, the Elevated had expanded its figures by 50,667,430.

IN the United Kingdom we find, according to the last official return, brought down to the close of the year 1884, that the authorised capital in respect of the lines now open for traffic was, at that period, £742,417,327, and the aggregate length of railways 17,512 miles. The total outlay in the construction of the lines now open, down to the end of last year, was £628,267,016, and the estimated further expenditure during the present year is upwards of £12,000,000. What may be classed as the 15 leading lines, which have from time to time absorbed so many of the smaller railways into their respective systems, represent £644,246,356 of the total capital of the various lines open, leaving £78,718,559 as the capital of the remaining lesser lines. The fifteen leading lines as above named have an aggregate length of 13,475 miles, an analysis showing that as respects mileage the Great Western Company stands at the head, while the London and North-Western Company has the largest amount of capital, being £101,771,907, with a mileage 1794 miles in length. As regards capital the Midland Company is next in amount with £76,549,267, and 1270 miles of railway. The capital of the Great Western Company is £75,108,424, and its length of railway 2301 miles. Then follow the North-Eastern, with a capital of £57,650,895, and 1536 miles of railway; the Great Eastern, capital £41,087,103, and 919 miles of railway; the Caledonian, capital £39,324,700, and 772 miles; the Great Northern, capital £35,380,050, and 949 miles; Lancashire and Yorkshire, capital £41,852,949, and 496 miles; North British, capital £33,576,211, and 984 miles; Manchester, Sheffield, and Lincolnshire, capital £27,248,627, and 291 miles; London, Chatham, and Dover, capital £25,634,008, and 176 miles; London and Brighton, capital £23,768,899 and 455 miles; South-Eastern, capital £21,915,824, and 385 miles; London and South-Western, capital £29,455,931, and 818 miles; and Glasgow and South-Western, capital £13,921,570, and 330 miles.

NOTES AND MEMORANDA.

THE deaths registered last week in twenty-eight great towns of England and Wales correspond to an annual rate of 15·9 per 1000 of their aggregate population, which is estimated at 8,906,446 persons in the middle of this year.

THE accountant to the North of England Board of Arbitration has issued his returns for the months of July and August. The total make in the two months ending August 31st was 61,143 tons, and the average net selling price was £4 17s. 7¾d. The return is looked upon as satisfactory, as it is the first time in two years that prices have received a check in their downward course.

ACCORDING to Professor Tyndall, who has studied the absorptive power of gases for low temperature heat, the following are the comparative absorption powers of various gases, each of the pressure of 1in.:—Air, 1; oxygen, 1; nitrogen, 1; hydrogen, 1; chlorine, 60; bromine, 160; hydrobromic acid, 1005; carbonic oxide, 750; nitric oxide, 1590; nitrous oxide, 1860; sulphide of hydrogen, 2100; ammonia, 7260; olefiant gas, 7950; sulphurous acid, 8800. The absorptive power of the three permanent simple gases for dark heat is thus very small, while that of compound gases is very considerable.

IN continuation of previous experiments on the effect of high pressures on low organisms, MM. Cretes and D. Cochin state that the vitality of *torula* is not destroyed by a pressure of 300 to 400 atmospheres continued for several days. Examination under the microscope shows no perceptible change in the form or appearance of the cells, and when afterwards brought into contact with saccharine solutions they multiply, and otherwise behave in a normal way. Under the same pressure alcoholic fermentation always takes place after some time. When fermentation occurs under high pressures, the development of carbonic acid appears to ensue under special conditions of molecular equilibrium.

IT is generally supposed that the north arctic zone is extending, and proof is assumed in the increase of ice on the Eastern shores of Greenland, and in the fact that barley, which was successfully grown in Iceland from its first settlement in 870 down to the middle of the fifteenth century, is no longer cultivated here. The Icelandic Government have, however, lately attempted to grow barley in the island on a considerable scale, and the results were very favourable. Norwegian barley from Altenfjord, the extreme north of the barley-growing zone, was planted and fit for cutting in 89 days. The decline in barley cultivation in Iceland is really due to the fact that cattle-breeding paid better.

ACCORDING to the latest official returns, the output of coals in New South Wales for 1884 exceeded that of the previous year in quantity by 227,652 tons, and in value by £101,135 7s. The output of coal from the time of the opening of the coal seams of the colony amounts to 31,313,372 tons, the value being £15,709,291. The average value per ton up to and including the year 1857 was 11s. 10·72d.; the average price per ton for the years 1858 and 1884, inclusive, was 9s. 11·33d. The output of coal for 1884 was 2,749,109 tons; average value per ton, 9s. 5·71d.; total value, £1,303,077. The year's exports reached 1,690,763 tons; average value, 11s. 0·15d.; total value, £931,045; leaving 1,058,346 tons for home consumption.

LONDON is, as is generally known, supplied with water from the rivers Thames and Lea, and from certain springs in the valleys of the Thames and Lea, supplemented from Chadwell springs, and from ten wells in the north of London, and ten wells in the south of London, all down to the chalk. The proportions for the month of August, 1885, are nearly as follows:—From the river Thames and certain chalk springs in the Thames Valley, about 58 parts of the whole; from the river Lea and certain chalk springs in the Lea Valley, about 30 parts of the whole; from the ten chalk wells on the north of London, about 5 parts of the whole; from the ten chalk wells on the south of London, about 7 parts of the whole.

IN London, last week, 2438 births and 1081 deaths were registered. Allowing for increase of population, the births were 216, and the deaths 355, below the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes, which had been 15·8, 15·6, and 15·7 in the three preceding weeks, declined last week to 13·8, which was considerably lower than the rate recorded in any week since the first publication of the Registrar-General's weekly returns. During the first twelve weeks of the current quarter the death-rate averaged 18·3 per 1000, against 20·3 in the corresponding periods of the nine years 1876-84. In Greater London 3193 births and 1360 deaths were registered, corresponding to annual rates of 32·0 and 13·6 per 1000 of the population.

IN London on Sunday the thermometer did not exceed 49 deg. throughout the day, and the mean temperature for the twenty-four hours was 40·5 deg. This is the lowest temperature observed in September during the last seventy years, although sixty-one years ago, on September 28th, the mean was 40·7 deg. The thermometer on the grass, exposed to the open sky, fell to 24 deg. in London on Sunday morning, and ground frosts were experienced over the greater part of the country. The temperatures of the few days were those usually experienced at the end of November or at the commencement of December. Snow fell in London on Friday, which, according to available records, is the earliest occurrence during the present century; there is, indeed, but one instance, October 7th, 1829, of snow falling in London before the latter half of October.

TAKING the average amount of organic impurity contained in a given volume of the Kent Company's water during the nine years ending December, 1876, as unity, the proportional amount contained in an equal volume of water supplied by each of the metropolitan water companies, and by the Tottenham Local Board of Health, was:—Kent, 0·5; Tottenham, 0·6; Colne Valley, 0·6; New River, 0·7; Grand Junction, 1·2; Southwark, 1·5; Chelsea, 1·6; East London, 1·7; Lambeth, 2·1; West Middlesex, 2·1. In connection with this statement from the report of Dr. Frankland, it may be interesting to state that while the most impure water supplied to London, according to the above, contained of organic carbon and of organic nitrogen respectively 0·096 and 0·030 grains per 100,000, the Birmingham supply contained 0·152 and 0·042, and the Loch Katrine water of Glasgow contained 0·274 and 0·038 grains per 100,000. The London water at the worst was thus better than the Loch Katrine water.

THE phenomena of dew form good illustrations of the laws of radiation. When the sun has sunk beneath the horizon of any place, bodies of small mass and great radiating power for dark heat, such as the leaves of plants, become quickly cooled by their uncompensated radiation into space. They thus cool the air around them, until the air becomes so cold that it can no longer retain in the viewless state the aqueous vapour which it holds; part of this is consequently deposited in the form of dew, or of hoar-frost, if the temperature be sufficiently low. The following are the laws which regulate the deposition of dew as given in *Nature* by Professor Balfour Stewart:—(1) Dew is most copiously deposited under a clear sky. (2) And with a calm state of the atmosphere. (3) It is most copiously deposited on those substances which have a clear view of the sky. (4) And which are good radiators and of small mass. (5) And which are placed close to the earth. The first of these conditions is essential, because the cooling which precedes the deposition of dew is owing to radiation into free space. If there are clouds these will radiate back to the body, and thus prevent it from cooling fast enough. We see, likewise, the necessity for a calm atmosphere, when we reflect that dew can only be deposited by means of the body cooling the air around it; if this air is constantly renewed, the body not being able to cool a large body of air, dew cannot be formed. It is very manifest why the body must have a clear view of the sky, and why it must be a good radiator in order to promote the deposition of dew. Also why it must not be of a great mass.

MISCELLANEA.

THE new steel works on the basic system erected by the Glasgow Iron Company are just about finished, and it is expected that they will begin operations without delay.

THE Carron Company, Carron, Stirlingshire, has obtained a silver medal—the highest award given—for its exhibits at the Mining Exhibition held at Glasgow, in connection with the visit of the Iron and Steel Institute to that city.

MESSRS. BOLCKOW, VAUGHAN, & CO. have come upon a thick bed of salt at their bore-hole near Eston Jetty, to the east of Middlesbrough. The salt was reached at a depth of 1550ft., and already 62ft. have been pierced through without reaching the bottom of the bed.

MESSRS. LANCASTER AND TONGE have been awarded the silver medal at the Glasgow Mining Exhibition for the following exhibits:—The Lancaster patent high-pressure steam traps, the Lancaster spiral spring piston, the Lancaster silent pump, to work with steam or compressed air.

AN electro-mechanical clock of simple design, but of continuous action, is being introduced by Mr. B. F. Watkins, of 27, Leadenhall-buildings, E.C. A common open-circuit battery, as used for telephones and electric bells, provides the motive power, and relieves the owner of the necessity for clock winding daily or weekly.

NOTICE is given that the address for the general offices of the Eastern Telegraph and the Eastern and South African Telegraph Companies from the 29th ult. will be Winchester House, 50, Old Broad-street, London, E.C. The London telegraph stations remain unaltered, viz., 11, Old Broad-street, 3, Great Tower-street, 8, Leadenhall-street, and 41, Parliament-street, S.W.

IT has been said that further progress with the making of the Dore and Chinley Railway has been postponed for two years. On inquiry it is found that there is no foundation for the rumour, and that the making of the line is to be proceeded with in due course. Five years were given for its completion from the passing of the Bill, and the promoters are confident that they will be able to finish the work and open this new line in Derbyshire within the statutory time.

IN one of the galleries of the Oscar gold mine, on the Bömmel Island, on the west coast of Norway, a block of auriferous quartz was last week broken out, the value of which is estimated at about £70,000. The deposit here has now been worked for about a year and a-half, and the working has, according to the reports of the owners, already returned the sum invested. The work is being pushed on with all despatch, as it has been found that the quartz increases in gold downwards.

A COPY has been sent us of "Examples of Machine Construction and Drawing," prepared to meet the requirements of the Government science examinations, by Mr. Thos. Jones, head master Salford Science School, and master of engineering drawing at the Central School, Manchester. The book costs but 6d., contains twelve plates of examples of a useful, because practical, and not fanciful kind. They all give evidence of practical knowledge; the only fault to be found is the square corners in the journals of a crank shaft, and a straight axle on Plate 12.

AT Leeds on Tuesday the adjourned inquest was held respecting the death of the two men, Greenwood and Feirns, who were killed last week by the explosion of a boiler at the cloth-finishing mills of Messrs. Kitson. The evidence was to the effect that the boiler was an old one, and had been repeatedly repaired. Three Galloway tubes had been removed and never replaced, though Greenwood had complained of the danger. The jury returned a verdict of "Death from misadventure." They thought Mr. Kitson and the man who repaired the boiler were to blame, and trusted that the Board of Trade would take the matter up.

THE winter session of the Charterhouse Science and Art Schools and Literary Institute—one, we are informed, of the largest science and Art Schools in the United Kingdom—will, under the presidency of the Rev. H. Swann, M.A., commence on Saturday, October 3rd. During the late session about 800 students, mostly elementary teachers, availed themselves of the privileges afforded by this institution, and of this number upwards of 500 presented themselves for examination and were successful in obtaining a large number of first-class certificates and also a goodly number of honour's certificates, awarded by the Science and Art Department of South Kensington. The only Royal Exhibition taken by a London student this year was by a member of this science school.

ON September 1st the Lindholmen Engineering Works, Gothenburg, launched the Sviet steamer, a vessel of some novelty, as being the first steamer built for the carrying of petroleum in tanks in the hold from Batoum and Odessa to Mediterranean ports. Her dimensions are: Length between perpendiculars 289ft., breadth 36ft., and depth in the hold 24⅜ft. Her capacity is 1700 tons dead-weight, and the engines will give her a speed of 10 knots per hour when loaded. The Sviet—Light—which is built throughout of soft Motala Bessemer steel, has been constructed for the Russian Steam Navigation and Trading Company, of Odessa, an association which intends to compete with the American oils in the European markets by the saving of transports on their own in the manner indicated. By the establishment of this new route, the link which was wanting for the completion of the Russian oil trade to Europe from the Caspian Sea will have been added. The same company has ordered three similar vessels in Sweden.

MESSRS. F. PEARN AND CO., of West Gorton, Manchester, have recently completed the erection of a powerful hydraulic plant at the Lambeth Works of Messrs. Parker and Co., London. The engines are of the tandem type, with direct-acting compound high-pressure cylinders 18in. diameter, and low-pressure cylinders 28in. diameter, with a stroke of 15in. and a steam pressure of 50 lb. The rams are 2¼in. diameter and 15in. stroke, working against a pressure of 3000 lb. per square inch. The exhaust steam is passed through one of Berryman's patent feed-water heaters made by Messrs. Joseph Knight and Co., of Tipton. In connection with the pump is an accumulator with 10in. ram and 10ft. stroke, loaded with 110 tons of cast iron weights made up of a series of slabs in halves, each weighing 7 tons. The engines are arranged to work direct to the presses by means of a hydraulic governor, and can be used when the accumulator is laid off for any purpose. These engines have now been at work for about two months, and have, I understand, acted very successfully, giving entire satisfaction.

HER MAJESTY'S ship Severn, which was launched on Tuesday, is an unarmoured fast steel cruiser, belonging to the class of the twin screw protected corvette, which includes the Thames and the Mersey. The Severn has been about two years in the course of construction, and is estimated to cost about £160,000. Her principal dimensions are as follows:—Length between the perpendiculars, 300ft.; extreme breadth, 46ft.; mean draught of water, 17ft. 9in.; load displacement, 3600 tons. Her armament will consist of two 8in. breech-loading guns, ten 6in. breech-loading guns, one 9-pounder boat and field gun, one 7-pounder boat and field gun, six 1in. Nordenfelt guns, and two 45in. Gardner guns. She will carry Whitehead torpedoes, and discharge them above and below water on each broadside. Although the hull is unarmoured, the vessel is provided with a 9in. thick armour steel-faced conning-tower, steel protective horizontal deck-plating 2in. thick, and 3in. of the same on slopes. She will be fitted with horizontal compound engines of 6000 indicated horse power, made by Messrs. Humphry, Tennant, and Co., of Deptford. There are two propellers, and the vessel is estimated to attain a speed of 17½ knots per hour. The authorised complement of her coal bunkers is 500 tons, and accommodation is provided for 300 officers and men. It is expected that the Severn will be ready for her first commission in a few months.

PUBLISHER'S NOTICE.

*** *With this week's number is issued as a Supplement, a Two-Page Engraving of the Express Engine, Emperor Ferdinand's Northern Railway, Austria. 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.

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

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

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

E. C.—*You can find the date of the patent by making a search at the Great Seal Patent-office. Consult the subject matter indexes, under the head "Governors for Steam Engines."*

W. C. (Plymouth).—*On the London and North-Western Railway the tender tanks are filled while the engines are running, the water being scooped up from a long shallow trough between the rails. The system is not in use on any other English line.*

C. Y. C. (Walsall).—*Multiply the head in feet by* ·4335. *The result is the pressure in pounds per square inch. Thus, let the head be* 723*ft., then* 723 × 0·4335 = 314·305 *lb. per square inch. The diameter of the pipe does not affect the pressure, which will be the same in a pipe* 1*in. or* 100*in. in diameter.*

J. N. B.—*The effective area for pressure on the back of a slide valve is the area of the exhaust bridge, added to that of any port or ports covered by the valve besides those under the bridge, which are not to be counted. In other words, any portion of the valve face which is in contact with the metal of the port face is to be deducted.*

ROCK DRILLS.

(*To the Editor of The Engineer.*)

Sir,—Will any reader give me the names of the makers of the best steam rock drills, suitable for open railway cuttings? N. R.

September 24th.

MEETING NEXT WEEK.

Society of Engineers.—Monday, Oct. 5th, at 7.30 p.m.: A paper will be read "On Opening Bridges on the Furness Railway," by Mr C. J. Light, of which the following is a synopsis:—Buccleuch Dock Bridge: General description—comparative estimates with other systems—details of the novel elements in the structure and calculations for the same, with record of tests—great facility in moving the bridge—actual cost. Ulverston Canal Bridge: General description and conditions of the design—comparative estimates—details of structure—actual cost.

BIRTH.

On Sept. 25th, at 3, Lisgar-terrace, West Kensington, W., the wife of Geo. Waller Willcocks, M. Inst. C.E., of a son.

DEATH.

On the 19th inst., Francis Mauduit, Civil Engineer, aged 56 years.

THE ENGINEER.

OCTOBER 2, 1885.

INDIAN COAST SURVEYS.

Recent shipping disasters upon the coasts of India have led the Indian press to take considerable notice of the state of the charts by which mariners are now guided in their navigation around them. It is alleged that many of these charts have become exceedingly incorrect, owing to the changes which have taken place since they were prepared. That such is the fact will surprise no one who has been able to observe the alterations that are apparent even to those whose opportunities for such observation have been limited. No dweller near an Indian seashore can have failed to remark with what rapidity its natural features change, owing to the marvellous speed with which the troublesome coral insect builds up its deposit. One of the journals referred to names an instance in which, during seven years, a small speck of coral deposit appearing above the surface of a lagoon rose and extended itself into quite a respectably sized island. If such a growth can be accomplished when the operations of the insect have to be carried on between wind and water, as it were, it is easy to conceive how far more rapid must be the development when they have the advantage of being conducted in deep and perfectly still water. The late experiences referred to show that the insidious enemy of our ships has indeed wrought marvellous changes—changes that constitute a really serious danger. We can therefore understand and sympathise with the demand made by our Indian contemporaries that a full re-survey of their coasts should be proceeded with with the least possible delay.

Few services were more popular or achieved greater distinction in the past than that which was formerly known as the Bombay Marine. Its officers included many men whose names became famous in the war annals of our eastern dominions; but, celebrated as the service justly became in that connection, it was, perhaps, even more so for the peaceful, but to the full as useful service that it performed in the preparation of those charts which have so long served to guide the navigation of eastern seas. It in no way derogates from the value of what the Bombay Marine achieved in this direction to say that its work has now, to a great extent, become obselete. During the many years—some forty or fifty perhaps—which have elapsed since the larger proportion of the Indian charts were prepared, the little silent worker has died in its myriads, its self-entombment having brought about changes rendering the work of the chart-maker past date. Another cause has also tended to the same end. The great Indian rivers bring down with them in suspension an enormous amount of deposit, which gradually spreads along the coast line on either side of their *embouchures.* Shoals are thus formed with a rapidity to which European dwellers, with their experience of rivers having but comparatively short courses, are altogether unacquainted. Since the abolition of the Bombay Marine as a distinct service at the time of the transfer of the Government of India from the great company to the Crown, the work of maritime survey has proceeded but languidly. The vessels employed upon it have been exceedingly few in number, while the vast increase in eastern traffic has caused the attention of their commanders to be directed more towards new fields than to maintaining a watch upon those once dealt with which have been gradually, but surely, changing their character. It has become no uncommon occurrence for the masters of vessels lost in the waters with which we are dealing to plead that the shoal or reef on which they have come to grief is not laid down upon the official charts. In such cases it has rarely been decided that they have been in error, or merit any punishment for want of care in navigation.

It is evident, therefore, that this matter should be taken in hand in a spirit of thoroughness. The staff of vessels should be increased to a proportion which shall enable re-surveys to be proceeded with with a simultaneousness which shall afford a prospect that newly found obstructions shall be delineated in time to prevent much further loss of ships. The extended surveys which the growth of trade has rendered necessary in the Red Sea, in Australian waters, and along the African coast lines, have undoubtedly rendered it difficult for our Admiralty authorities to devote adequate attention to similar work on the Indian coasts, which is, however, not one whit less necessary than in the before-named localities. Whether or no the changed aspect of political affairs in the East may make it desirable to revert to a considerable extent to the old system of a separate naval force for India is of no moment as affecting this particular question of re-survey. The service is scarcely one in which local experience would give any decided advantage; while a few years' surveying work to the officers of the Royal Navy in turn could not but prove of benefit to them in their advancement in a highly important branch of naval training. Maritime surveying is not, nor should it be, a speciality. Every executive officer in the Navy ought to be an adept at it, for knowledge of it is necessary on very many occasions. But some course must be determined upon, and that soon, if the complaints we hear of vessels lost upon newly-formed obstructions are not to increase seriously. The large size given of late years to our ships, and their consequently increased draught of water, has rendered but a slight growth of the previously discovered and marked obstacles of some twenty or thirty years ago a very grave source of danger in the present day. According to the statements of our Eastern contemporaries, there is scarcely a mile of the Indian coast lines whereon changes, more or less important, have not been going on. When the Bombay Marine officers completed their work, it was, doubtless, expected by the authorities that in this matter they might rest and be thankful. That comfortable hope, it is certain, can no longer be indulged in, and the sooner this fact is realised, and action taken, the better for every interest connected with our Eastern Dependencies.

THE DEVELOPMENT OF INVENTIONS.

Inventions as a means of making money have been more than once considered by us. A letter which we have recently published suggesting the formation of a company for, or the application of the co-operative principle to, the development of inventions devised by persons themselves too poor to make anything of them, needs, however, some comment. In the first place, the term invention is itself very comprehensive, embracing a large field for reflection; and the man proposing to himself to seek his fortune by making even one invention must take many things into consideration. The species of inventor to whom we more particularly refer is that usually known as "the poor inventor," a class comprising men more or less enthusiasts, who have certainly done much for the welfare of mankind but nothing for themselves; men who have sacrificed their time, health, and the little worldly wealth they possessed in their attempt to perfect their schemes. They deserve and receive sympathy, though it, unfortunately for them, has seldom taken practical form in material help; and where material help has been afforded it generally came too late. Another class of inventor, a class with whom it requires a good deal of mental effort to sympathise, comprises men who, all other trades failing them, take to making inventions, though perfectly ignorant of all the fundamental principles upon which any mechanical combination must be based if it is ever to be of use. Such as these are usually deaf to either advice or instruction. The Patent-office is full of examples of patents taken out for either impossible contrivances or for things so old that the term fossils is the only fitting definition for them.

Our correspondent points out that working men may and do devise things which are lost to the world because of the poverty of their inventors, and suggests, as we have said, the application of the co-operative system either directly, or working under the guise of a company, to provide a fund for the development of the ideas of poor men. The theory is very nice, and not only looks feasible, but in a certain way is so, though not exactly in the sense in which our correspondent puts it. A single company to investigate and test even in a preliminary manner—to, in fact, be a "weeding out" association for the United Kingdom patents—would need to be a large one with a great capital; for a huge staff of highly-paid experts in all the multifarious subjects for which patents are or may be obtained would be essential for the work; and besides this, eminent patent lawyers should be retained to see that in the legal sense the specifications were properly drawn. When this was all provided for the company would be only on the threshold of its work. Taking two examples or sections of patents, namely, those dealing with pure mechanics, and those connected with steel making; the most expert judges of inventions in either of these sections might probably be deceived or mistaken, rejecting that which, if fairly tested, was good, or *vice versâ.* We do not, of course, include schemes on their face fallacious, unsound, and betraying the ignorance of their projectors. This subject is so wide as to be quite beyond the compass of an article such as this. All we can do is to skim the cream of the arguments against anything like the formation of a single huge patents development company.

Another correspondent has told us that he sought the aid of some persons or firm professing to give help to inventors, but that on applying to them he found the cost would exceed his means, or else absorb the largest portions of the profits, if any. Exactly so; and if our correspondent had been a good financier, reflection must have shown him that the money they would lend him, or expend on his behalf, would be a purely speculative investment of a decidedly risky and hazardous nature, and therefore demanding proportionately high interest as an offset to the risk incurred. Our correspondent speaks of the excellence of two inventions of his, though he does not tell us whether they have been crucially tested, a chief and essential item of evidence as to the value of any invention; and he and all other inventors seeking monetary aid for their schemes must remember that tests of new contrivances very much resemble well sinking in a place the geology of which is unknown. Points needing alteration present themselves not merely at the first, but at a third or fourth trial, even in devices originated by well-trained and experienced men, who are not often destitute of means to develope their schemes. Much more will this be the case in the trials of schemes originated by persons partly, or totally, amateurs to the work in hand. It is certain that such trials cost much money, and such a company as that suggested by our correspondent would perforce have to take a large—or what the "poor inventor" would in most instances consider a large—share of the profits, if any, if it were to continue in existence. The successful inventor would, in a word, have to pay all the losses incurred in carrying out the schemes of the unsuccessful inventor. Our correspondent mentions the examination of inventions before they are taken up; but inventors, however poor, do not need the aid of money to obtain a good opinion on the merits of their schemes. If they are men capable of inventing any contrivance that can be illustrated by drawings, they should be possessed of sufficient knowledge of drawing to be able to show their ideas on paper. An advertisement in any respectable journal for a firm willing to look into the thing will almost certainly bring at least one or two replies, and the inventor sending his sketches and description will in a moderately short time be told whether his scheme will be taken up or not. If two or three good firms decline it, the inventor may, as a rule, abandon the thing. We may be told, "Oh, schemes are declined from jealousy, trade rivalry, or even from a dishonest motive on the part of the rejector, who will recast the scheme, patent it in another form, and make profit, the whole of which they will keep out of the poor inventor's brains." No respectable firm would act thus, and even were such a thing possible, then what better security would the inventor have in the case of a company specially professing to aid him? Such a company, before entertaining the inventor's application for aid, would lay the scheme before its professional staff, which might either be formed of men acting simply as consulting engineers, or else arrangements would have been made by the directors with certain firms to examine and report upon the merits of this or that invention, on being paid a fee as a matter of course. The same malpractice could be carried on under the company system as in the other. Of the two classes of poor inventors, namely, the penniless man, whether professional or amateur, or the working man, the first is not altogether without access to the ear of the capitalist. Men are ever ready to speculate more or less, and either by advertisement or through the aid of a respectable solicitor, a poor inventor has a very tolerable chance of at least getting a hearing from a man with money for which he seeks an investment; and we are of opinion that most inventions that reasonably comply with all the conditions essential to their commercial success are taken up, though the originators do not always reap that share of the profits which they and their friends think they ought to get.

As regards the inventions of working men, the working man has the matter in his own hands. He can save, if he will, out of his annual drink bill as much as, if all the men employed in a single large works clubbed together, would make an inventions development fund, and by its aid any workman's scheme could, at all events, get quite as thorough—and, perhaps, a more really honest—trial, as it would be, under the immediate supervision of the delegates of the club themselves, than would be attainable if in the hands of any large limited company. Although working men have now and then brought out good inventions, yet such cases are rare. The average working man is not an inventor. His daily routine is of a narrow and "groovy" nature. Although in politics, too, he may be usually Radical, in his capacity as a tradesman he is generally a stout Conservative, and averse from change. After all, the only class of invention he has facilities to devise, or that his daily routine might suggest to his mind, is that of labour saving, and this is the class to which his interests are opposed. Any inventor, whether he be working man or otherwise, if he really has what our American cousins call "genuine grit" in him, can on the lines we have indicated above get very fair chances of notice for his ideas. A knowledge of drawing sufficient to enable him to convey to any competent engineer an idea of his scheme may be soon acquired at any evening drawing and science school, while as to models, the working man ought to be able to spare enough time from the public-house to make his own; and working men have done this and do do so. The amateur or other inventor of that class could soon acquire enough knowledge both of drawing and the use of tools to make such drawings or models—rough though they might be—as would suffice to explain his views; the action of many mechanical contrivances can be shown by wood slips fastened on a smooth board with bits of wire or hardwood pegs as pivots. Few inventors are so utterly destitute as to be altogether unable to help themselves by such means as those we indicate. In conclusion, we would point out to would-be inventors the expediency of considering well the character of the sea they are proposing to adventure on, but, having once embarked, to grasp the helm and use all their energies to reach by their own exertions their hoped-for haven of fortune.

THE LAYING-UP OF STEAMERS.

A very interesting discussion is taking place in the chief daily newspaper of the North of England as to the desirability of laying idle a part of our mercantile marine, and as to the vessels which should be laid idle, if any. This discussion in the *Newcastle Daily Chronicle* seems to have arisen out of the proposed combination of shipowners. It appears to be the general opinion of the correspondents who have taken part in that discussion that most of the steamers which are at work are running without profit, and in some cases at an actual loss, and very naturally the question arises as to the best method of altering that state of affairs. On the one hand, it is contended that there ought to be a general, a systematic, and a combined effort to improve the freight market, and that this can be best done by laying idle a large proportion of the tonnage, either by each steamship manager forcing a proportion of his tonnage into idleness for a given time, or by every one of the associated vessels being laid idle at each port for a month, as needed. But the contention on the other side is that there are steamers which cannot now run at a profit, and that it is this class of vessels which ought to be laid idle, and that by the individual acts of the managing owners; whilst the vessels which can do more than make ends meet ought to work continuously. There can be no doubt that on the abstract question the argument would be in favour of the latter method of righting the evil, and if it be replied that the individual action is slow in being brought to play, the reply is that the combination which is proposed would have to depend upon that individual action for its enforcement. It is, however, very difficult to bring about either of the methods, for the interest of the managers of the vessels is sometimes found in the continued working of the ships apart from a profit in the working, and it is in this and in the inertness of the shareholders that the danger exists. If the latter would at once exert their influence, and put a stop to the working of steamships at a great loss, the question would be settled in a month or two. But it is to be noticed that in the meantime, whilst something like a survival of the fittest is going on, there is slowly operating that decline in shipbuilding which we have more than once pointed out in The Engineer as in progress, and as the loss is constant, the freight market will in time be righted, whilst outbreaks of war might right it at once.

EMERGENCY BRAKES.

If years of experience with different kinds of brakes has shown anything, it is that emergency brakes are useless in an emergency. Most of the Board of Trade officers have had this fact very strongly impressed upon them by actual experience. But something has happened to Major-General Hutchinson, for he has, in a report on an accident in May last on the Belfast and Northern Counties Railway, actually recommended an emergency brake. It has often been considered undesirable that continuous brakes should be used in running into terminal stations; Major-General Hutchinson himself, in an emergency, finding it impossible to avoid the conclusion that the accident in question would not have happened if the train had been fitted with a continuous brake, recommends such a brake, but discountenances its use in running into terminal stations. About thirty people were more or less injured by the accident, the number probably being high, as the collision only occurred at the time many people would be standing up ready to alight. The description of the incidents in the use of the steam brake on the engine and the hand brakes shows that it was just a case in which a good continuous brake would have avoided the consequences of the irregular effects of common hand brakes, even at slow speed, when not used in concert. The report specifically states that had the train been fitted with a continuous brake, the collision with the buffer stops would have been avoided. It is to be hoped that Major-General Hutchinson will not again say anything in favour of the use, even at terminals, of continuous brakes in emergencies only, for drivers will certainly in such cases be very likely to find themselves relying upon an unready help.

MIDLAND TRADERS AND THE RAILWAY RATES.

The opposition to the railway companies upon the question of railway rates and charges grows. Lord Henniker's committee, which has already done great things, is seeking the closer co-operation of traders in some of the important provincial centres, and the committee seems likely to meet with a cordial response. The point to which the committee are just now most determinedly directing their efforts is an appeal upon the recent extraordinary decision of the Court of Queen's Bench in the cases of Hall *versus* the Brighton Railway Company, and Kempson *versus* the Great Western Railway Company. That decision, it will be remembered, reverses, if confirmed, all previous decisions of the Railway Commissioners upon terminal charges, and enables the companies to impose undefined charges for collection, storage, and other services, in addition to their authorised maximum rates. Lord Henniker's committee is determined to use every possible effort to upset the decision. A month must, however, elapse before the traders are in a position to know whether an appeal will lie, since the judges are at present divided, but state that they are willing to allow it if they possibly can. At an important Conference of Traders held in Birmingham towards the close of last week, Lord Henniker announced that the Great Western Company were not going to take advantage of the Queen's Bench decision at present; but inasmuch as it was obviously so unsafe to leave anything to the generosity of the companies, his lordship appealed for the co-operation of the provincial associations. The Midland traders met this solicitation by heartily determining to assist the London Committee by every means in their power. They proclaim that they view the recent decision with alarm. If it should be found that an appeal cannot be taken, the only course open to manufacturers is clearly that of fresh legislation with its attendant heavy expenditure. Lord Henniker strongly holds that the matter has become one which ought to be dealt with by a Government measure. Sincerely we trust that the traders may yet obtain that relief upon this grievous subject which is so earnestly called for.

"IMPROVED TRADE" REAL OR UNREAL.

Is the revival in trade *real?* This question is now being very freely asked in many quarters, and the answer is not alike in any. Iron has been called the backbone of England. When King Iron is depressed, other and lesser industries are not brisk. From Birmingham, the Black Country, Middlesbrough, and Scotland, there are indications of higher values; but the other iron centres of England—notably Yorkshire, Lincolnshire, Derbyshire, and Lancashire—show little response in upward tendency. Nor are there any strong signs in Wales that the beginning of the end has come, to be succeeded by stirring times and abundant prosperity. In the United States the most dispassionate observers betray little exultation over the diminution of stocks, the creeping of money from the banks, and the gradual renewal of confidence. In some parts it is regarded as little more than the natural increase caused by store-keepers and others making the usual provision for the autumn business. Well-informed business men are disposed to regard the animation reported from several districts as peculiar to these districts; and there have been unquestionably speculative operations which have influenced the markets in one or two quarters. It is unfortunate, while there is a gleam of sunshine, that the miners' leaders should again initiate a movement for an advance of wages to the extent of 15 per cent. This agitation, if persisted in, will certainly disorganise business in the Midlands, if not over the whole country.

OCEAN MAIL SERVICES.

We learn that our Australian colonies, or at least one of them, contemplate steps for the formation of what is termed a "Federal Mail" service. We presume that expression to imply a union of the several Governments constituting our Australian colonies to provide for their mail service to England on a basis wholly distinct from that now working in connection with the Imperial Post-office. We doubt if this question has been viewed in all its important bearings. If it has been, it seems to us that much that is vital to the common interests of Britain and Australia alike has been overlooked. It has been but so recently shown that the Australian colonists are one in heart and soul with ourselves in the determination to support the integrity of the joint empire, that we must feel surprised at any step being taken by them which must militate against its fullest security. Under the system of ocean mail services as at present conducted, the Imperial Government has available at any serious crisis the immediate services of a magnificent transport fleet. What that means, how powerful an auxiliary that fleet constitutes, has but of late been most fully shown. We cannot but think that any desire to break up a service which affords such advantages is of an unpatriotic tendency. Let our colonists improve and extend that service in any way, and in the fullest degree which may be possible; but any step which extends towards its extinction, or even partial disruption, seems to us to be fraught with possibilities of future danger which should certainly not be lightly disregarded.

RUSSIA AND EASTERN TRADE.

The great annual fair at Nischnij Novgorod, which has just been concluded, and which is of great importance to all Russian industries, has, it is said, disclosed some interesting new facts. The fair this year had been looked forward to with some apprehension, on account of the flat state of the market last year, which was further increased by the general stagnation in trade and industry. But business has this year come from a new unexpected quarter, says Russian journals, viz., Central Asia. Merchants came from Merv and other parts of Central Asia, whilst from Turkestan there was a great demand for goods which formerly used to be taken from India. Business with Central Asia is stated to be becoming so great that merchants have petitioned the Government to establish a branch office of the Imperial Bank at Khiva and Bokhara. The same journals maintain that every step forward in Central Asia will benefit Russian trade, and that although the enterprise may be costly, it will be fully repaid when the railway in Central Asia has been completed, which will immensely increase Russian commerce in these parts. It is urged on the Government to establish a separate office for trade industry and commerce, which now lie in the hands of the Ministry of Finance.

ST. PETERSBURG A SEAPORT.

A plan for making St. Petersburg a seaport is now under the consideration of the new Russian Office of Communication. The port is to be formed by two basins, where 100 steamers and 70 sailing ships will find accommodation at the same time. The depth of the basins is to be 22ft., and an auxiliary one will also be constructed, with a surface area of some 20,000 yards, and a depth of 10½ft., for the accommodation of grain lighters. The width of the quay will be 50ft., and it will be provided with railway, warehouses, &c. It is also intended to build bazaars and dwellings for some 2000 people close to the quay. The exact site of the port has not yet been fixed on, as the Crown wishes to make as cheap a port as possible, therefore preferring a site by the new canal, whereas the merchants of St. Petersburg, who have a voice in the matter, wish it close to the town, which would greatly increase the cost.

LITERATURE.

The Autobiography of a Whitehead Torpedo. By "Guns." Offices of *Engineering*, London. 1885.

We have not the least idea who "Guns" is, but this is a matter of little consequence. We have to deal with his book, not with the man himself; and of this book we have nothing to say that is not good. Its contents first appeared week by week in the pages of our contemporary *Engineering*. Its author combines a rare power of writing what is extremely amusing with a thorough technical knowledge of his subject. It is, we think, to be regretted that he hampered himself to some extent by making a Whitehead torpedo tell its own story, but he has taken very good care not to cripple himself too much, and at the risk of being accused of want of consistency, he makes his hero talk about things of which it could have no personal knowledge. The principal value, next to the practical information which it supplies, of the book lies, we think, in the racy sketches, many of them no doubt drawn from life, of modern types of naval men. Gunnery-Lieutenant Hand is an admirable portrait. He is so thorough in all he does, so put out when events do not move as he wishes them. His whole career is one long struggle with torpedoes. He reminds one of the man who spends his life training animals to perform tricks. Just when things are most wanted to go right they go all wrong, to his great worry and discomfiture; and we do not quite know whether to laugh at him or admire him. In Chapter III. will be found an excellent example of this. The admiral, Sir Shoreham Peerless, wants to see a torpedo trial. "I'll go away in the cutter, Captain Tarr," he says, "and will let you fire a Whitehead torpedo so that it will pass about 10ft. under her." Hand is entrusted with this duty; he looks out of a port and sees the cutter about 800 yards off: "Bless my soul," murmured Hand, "he doesn't expect us to hit her there, surely?" The torpedo is fired; the torpedo comes to grief. The admiral had been standing in the cutter with his arms folded, and a proud expression on his face, which seemed to say plainly, "Look at me, I'm in command of this splendid squadron, and if you wait a second you'll see a magnificent torpedo come right under the boat's bottom, fired from my flag-ship." The torpedo, instead of doing anything of the kind, ran into a ship, and broke its head off. "The next sight was the gallant Admiral and the midshipman of the boat trying to catch hold of my unfortunate head. This was no easy task, as the buoyancy was so little that my nose was only just above water, and on the slightest touch it disappeared. However, it was at last secured, and the gallant Admiral, panting and perspiring at every pore, returned on board with his prize, which was hoisted in in triumph." There was an inquiry, and "the private opinion of everyone, by no means privately expressed, was that the Gunnery Lieutenant was an idiot, and knew nothing about it." We must leave our readers to find out how Hand cleared his character, and circumvented the officers of the Vernon after all.

The book concludes with an exceedingly well-written and exciting narrative of a sea fight, with modern ships of war. The work is admirably illustrated, and we can assure such of our readers as take the least interest in naval matters that they will find "Guns" well worth reading.

The Gas and Water Companies' Directory, 1885. Edited by Charles W. Hastings. London: 22, Buckingham-street, Adelphi.

This is the ninth issue of a useful directory, which grows year by year in bulk and accuracy. The copy before us contains the Gas and Water Companies' directories and statistics in one volume for the United Kingdom and some continental places. The statistical information more especially is gaining value by its completeness, and will be found very useful to those requiring it for practical and theoretical purposes.

BOOKS RECEIVED.

Weekly Problem Papers, with Notes, intended for the Use of Students Preparing for Mathematical Scholarships. By Rev. J. J. Milne, M.A. London: Macmillan and Co. 1885.

Tables for Setting-out Curves from 101ft. to 5000ft. Radius. By H. A. Cutler and F. J. Edge. London: E. and F. N. Spon. 1885.

The Elements of Railroading: a Series of Short Essays Reprinted from the Railroad Gazette. By Chas. Paine. New York: The *Railroad Gazette* office. 1885.

Technical Vocabulary, English and German. By Dr. F. J. Wershoven. Leipsic: F. A. Brockhaus. 1885.

Architects' and Contractors' Handbook, and Illustrated Catalogue of Materials and Manufactures. Edited by J. D. Matthews. London: B. T. Batsford. 1885.

Pattern-making; a Practical Treatise, embracing the Main Types of Engineering Construction. By a Foreman Pattern-maker. London: Crosby Lockwood and Co.

The Advertisers' Guardian and Advertisement Agents' Guide. By Louis Collins. London: L. Collins. 1885.

Etude sur les Locomotives Anglaises. By Maurice Demoulin, Ingenieur des Arts et Manufactures. Paris: E. Bernard et Cie. 1885.

A Manual of the Theory and Practice of Topographical Surveying by Means of the Transit and Stadia. By J. B. Johnson, C.E. Designed for use of students and engineers. New York: J. Wiley and Son. London: Trübner and Co. 1885.

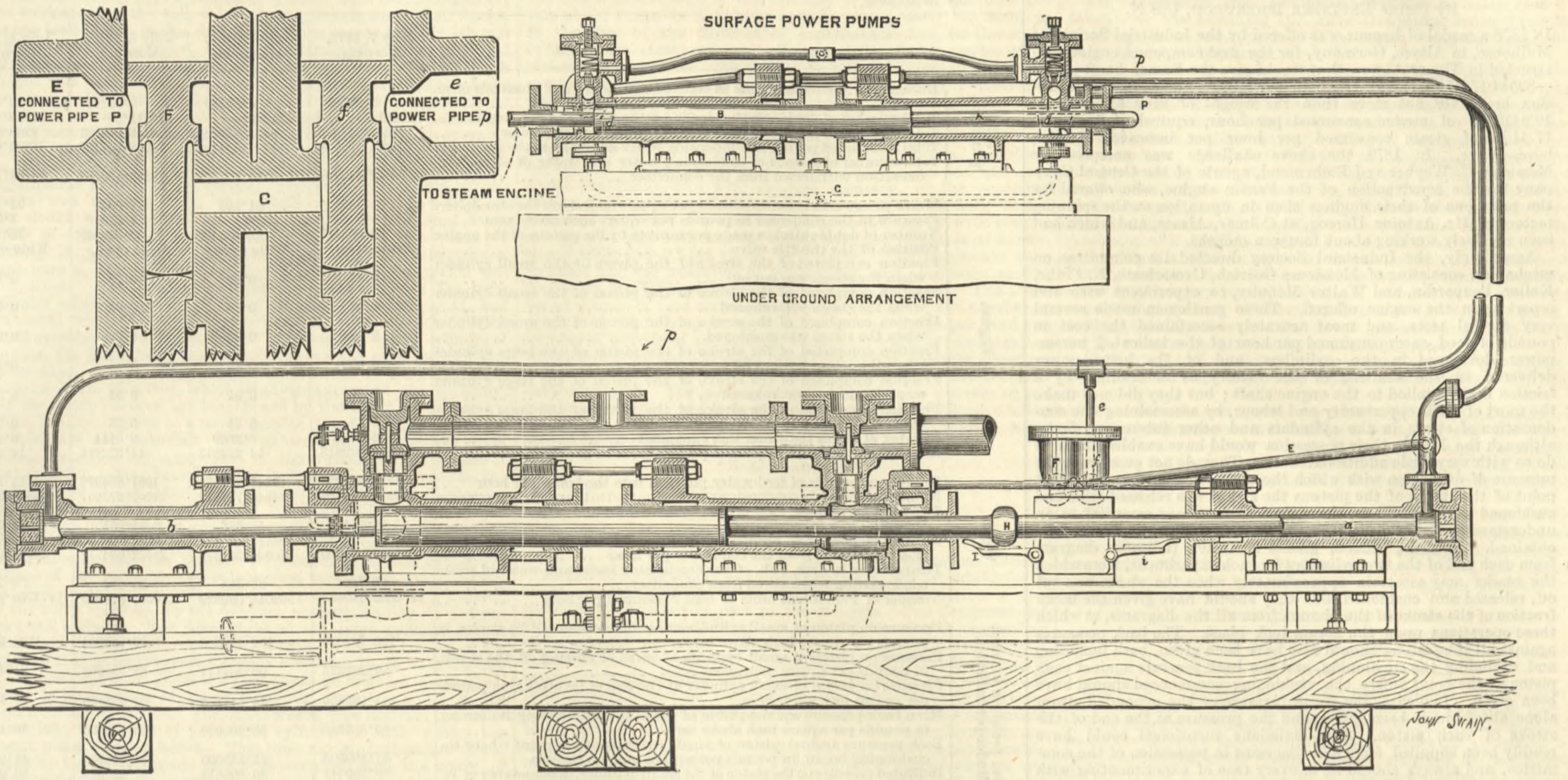
The Boilermakers' Assistant. By John Courtney. Edited by D. K. Clark, C.E. Weale's Series. London: Crosby Lockwood and Co. 1885.

Tables and Diagrams for Curving Tramway Rails, and for Making and Laying in Railway Crossings. By W. T. Olive, C.E. Lansdowne-road, Didsbury. 1885.

A Treatise on Practical Astronomy as Applied to Geodesy and Navigation. By C. L. Doolittle. New York: J. Wiley and Son. London: Trübner and Co. 1885.

According to an official report, antimony ore, associated with quartz, varying in thickness from 3in. to 4ft., containing a high percentage of antimony, is found in the Rockwell mines, between Cudgegong and Rylstone, New South Wales. Very little has been done at present on the lodes, but being so near the Rylstone Railway Station they are sure to be extensively worked.

HYDRAULIC PUMP, BROXBURN COLLIERY.

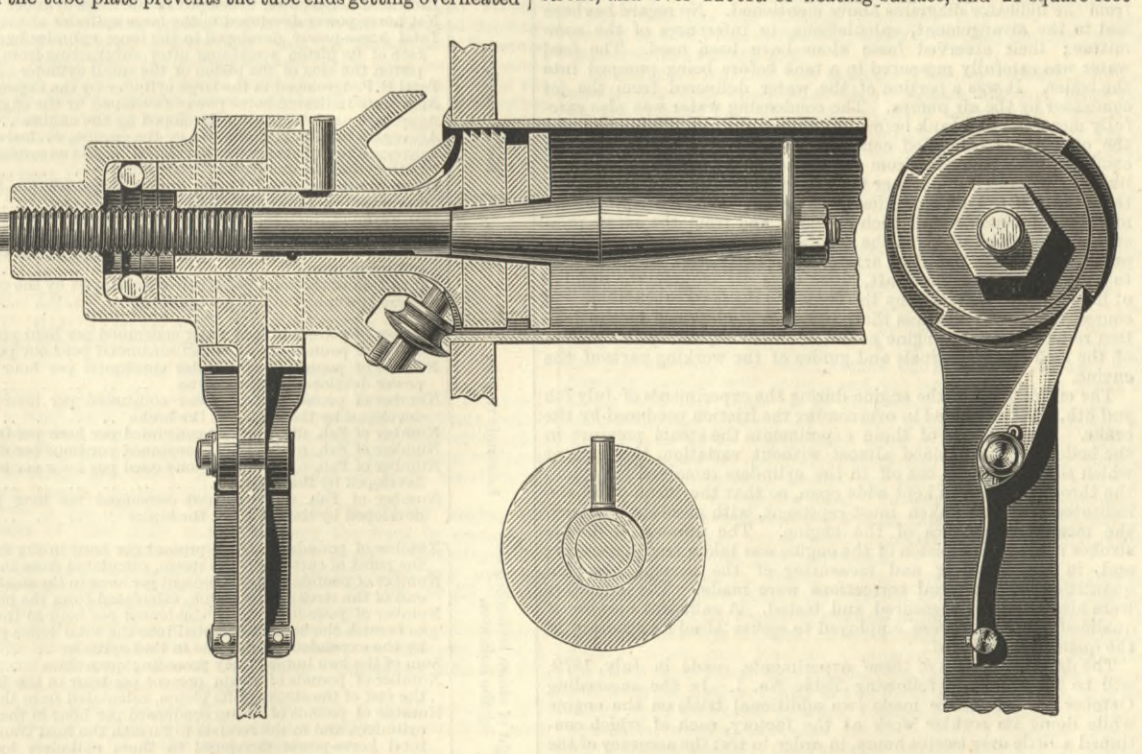


MOORE'S HYDRAULIC PUMP.

THE accompanying engraving illustrates an hydraulic pump patented by Mr. J. Moore, C.E., St. Vincent-street, Glasgow. The great difficulty experienced in draining dip workings in mines is well known to those who are acquainted with mining, and various means have been tried for this purpose, such as placing an engine on the surface and conveying the power to a pump underground through long lines of rods or wire ropes, compressing air on the surface to work an engine at the far end, taking steam down the pit to work an engine inside the workings, and also by hydraulic pressure. Amongst the latest improvements is the hydraulic pumping arrangement patented in this country by Mr. Joseph Moore, of San Francisco, California, which has been used there both for working inclines and for sinking. The illustration shows a pump which has just been started at the mines of the Broxburn Oil Company, near Edinburgh. The principle of this pump is to have two plungers on the surface worked by a steam engine, and connected by two power pipes to two power plungers underground, one on each end of the pump plungers. The steam engine in making a stroke from B to A displaces the water on the power plunger A, forces it down the power pipe P to the underground power plunger *a*, and causes the pump to make the stroke from *a* towards *b*. The water in the underground power pump *b* is forced up the power pipe *p*, following the power plunger B. When the steam engine makes its return stroke in the direction from A to B the water is forced out of the power plunger B through the power pipes *p* to the underground power plunger *b*, and the return stroke in the pump is made. The pump underground thus follows the motion of the engine on the surface, the water in the power pipes going backwards and forwards, and varying in pressure between 0 and 1000 lb. per square inch, thus forming a water rod, so to speak, between the engine on the surface and the pump underground. In order to make up any leakage which may take place in the power pipes, there is a small water tank placed above the level of the power plungers on the surface, and communicating with each of the power plungers through a pipe *c*. The water entering each of the power plungers has to pass a check valve—*d* shown dotted—which prevents it from running back when it is being forced down the power pipes. Any leakage is made up on the return stroke of the plunger when the pressure in the power pipe is nothing, the water being sucked in through these valves. F *f* are the pass-bye valves which regulate the stroke. These valves have sometimes an important part to play. If there is no leakage of course the strokes would remain the same; but should there be a leakage by which the stroke on one side would be shortened, the result would be that next stroke it would be driven up to the end of the barrel and might do mischief. This the pass-bye valves regulate. The pipe E communicates between the power pipe P and the top of the valve F and the pipe *e* between the power pipe *p* and the top of the valve *f*. There is a passage G between the bottom of the two valves. Under ordinary circumstances the pressure on the face of the valve keeps them shut, and the engine works as if they were not there. If, however, by any means, such as a leakage in one of the power pipes, the plunger gets nearer one end of the pump than the other, then before it strikes the end the catch H strikes the tappet I and opens the valve F. This allows the water to pass from the power pipe P through the valve F, through the passage G, underneath the valve *f*, which it lifts and passes through to the power pipe *p*, making the same pressure on both of the power plungers and stopping the pump. The stroke of the engine on the surface is completed with the water passing through the "pass bye" valves. When the return stroke is made the valve *f* prevents the water in the power pipe *p* from escaping. In the present arrangement at Broxburn the steam engine is placed at the surface and the pumps at the foot of a mine 800 yards long dipping at an inclination of 1 in 1. The pump plunger is 7¼in. in diameter, and the power plunger 4in., and the stroke 2ft. 6in. The power pipes are lap-welded malleable iron tubes 2in. in diameter and ¼in. thick. The pump works very smoothly and gives great satisfaction. It is started and stopped from the engine on the surface and requires no one to look after it. This is the second pump got by the Broxburn Oil Company. The first one has been running for over six months, and is also giving great satisfaction. The advantages of the system are that there are no moving parts, and the pipes can be taken round any bends, and with the high pressures used the arrangements underground can be made to take up very little room. The great annoyance of having steam underground is also avoided.

WICKSTEED'S TUBE BEADER.

THE accompanying engraving shows what appears to be a very effective tool for beading over boiler tubes, and supplies a long-needed want, brought out by Mr. C. Wicksteed, of Stamford Road Works, Kettering. The advantages of beading tubes are beginning to be better recognised, especially as the increased staying powers which it gives the tubes is much needed in the high-pressure boilers now so rapidly taking the place of low. It is claimed by the patentee, Mr. Wicksteed, that the flanging of the tube so strengthens it as to make it quite unnecessary to use ferrules in iron tubes; also that the turning over the ends light on the tube plate prevents the tube ends getting overheated



and gradually burning away. It will be noticed also that the rollers press outward and on the corner of the tube plate, thus aiding the action of the tube expander, which is previously applied, instead of shaking and loosening the tube as a hand tool would do. Hand beading, however carefully done, necessarily fractures the tube ends, whereas the tool referred to turns a perfectly unfractured bead over. The action is simple enough, as the taper bolt is drawn out to put the necessary pressure on the tube end and the three jaws are wedged tight into the tube plate. The ratchet on the one side of the handle turning the tool, on the other side turning at will the screwed cap at end of tool, which, as shown on end view, has only four catches, by which means an ordinary stroke will not turn it, but a long one will. We have seen the tool in operation, and it certainly did its work easily, speedily, and well. The details appear well carried out, but the main feature of the patent is the placing the rollers at an angle with the tubes, thus not only bringing the pressure to bear in the direction required, but enabling the rollers to accommodate themselves to the varying diameters of tubes nominally the same size, by leaving a little play on the axles.

EXPRESS ENGINE ON THE EMPEROR FERDINAND'S NORTHERN RAILWAY IN AUSTRIA.

THE locomotive illustrated by our supplement is the type of new engine adopted by the Northern Railway for its express service between Vienna and Prague. The leading dimensions are as follows:—

Length of stroke	6:2 mm.	= 24·88in.
Diameter of cylinders	400 mm.	= 15·75in.
Diameter of driving wheels ..	1760 mm.	= 5·77ft.
Diameter of leading wheels ..	1206 mm.	= 4ft.
Effective steam pressure	10 atmospheres	= 150 lb.
Area of grate surface	2 sq. metres	= 21·53 sq. ft.
Number of tubes	160	
Heating surface of tubes	103·8 sq. metres	= 1117 sq. ft.
Total heating surface	111·7 sq. metres	= 1202·7 sq. ft.
Wheel base	4450 mm.	= 14·60ft.
Weight in service	35·6 tons	
Weight empty	31·6 tons	

The average speed obtained is about thirty-seven miles per hour with a train of eight coaches. This engine is remarkable for its enormous boiler power compared to the dimensions of the cylinder. We have here an engine with a 16in. cylinder, 2ft. stroke, and over 1200ft. of heating surface, and 21 square feet of grate. We may conveniently contrast this with the last engine of which we published drawings—July 17th—namely, Mr. Aspinall's locomotive on the Great Southern and Western Railway of Ireland. That engine has 19 square feet of grate nearly, and 1050 square feet of heating surface, while the cylinders are 18in. by 24in. The speed of the Austrian engine is slow and its load light. The necessity for the large boiler is explained by the circumstance that the Austrian coal is inferior to English coal.

IN some articles in *Nature* on radiant heat, Professor Balfour Stewart fills space by such after-date wisdom as the following:—"The burning of gas in order to obtain illumination has nothing to recommend it. As it is used at present, it gives out a great deal of heat compared to its light, as well as a quantity of carbonic acid and other products still more deleterious." The idea that anybody beside himself knows anything about anything that has been going on in the world the past few years seems still further from his mind when we read the following: "It ought to be replaced by some kind of electric light, such as that proposed by Swan, where a thread of carbon is kept at a high temperature in a glass vacuum by means of an electric current. There the luminous effect is very large in comparison with the heat produced, besides which there is no foul air or other hurtful product." "Proposed by Swan!" Professor Stewart might make a few inquiries so as to tell his readers whether the *proposal* has been carried into practical effect, and whether abstract scientific aid might not be invited to mature so useful an invention.

AN ACCOUNT OF THE EXPERIMENTS MADE ON A CONDENSING COMPOUND ENGINE BY A COMMITTEE OF THE INDUSTRIAL SOCIETY OF MULHOUSE, IN ALSACE, GERMANY.

By Chief Engineer Isherwood, U.S.N.

In 1878 a medal of honour was offered by the Industrial Society of Mulhouse, in Alsace, Germany, for the first compound engine constructed in Upper Alsace, that would give the French horse-power —32544·17077 lb. raised 1ft. high per minute—as shown by a friction brake for not more than the weight of nine kilograms—19·8416 lb.—of steam consumed per hour, equivalent to about 17·44 lb. of steam consumed per hour per indicated English horse-power. In 1879 the above challenge was accepted by Messieurs C. Weyher and Richemond, agents of the Central Company for the construction of the Pantin engine, who offered for the prize one of their engines then in operation at the spinning factory of Mr. Antoine Herzog, at Colmar, Alsace, and which had been regularly working about fourteen months.

Accordingly, the Industrial Society directed its committee on mechanics, consisting of Messieurs Goerich, Grosseteste, X. Fluhr, Keller, Poupardin, and Walter Meunier, to experiment with and report upon the engine offered. These gentlemen made several very careful tests, and most acurately ascertained the cost in pounds of feed water consumed per hour of the indicated horses-power developed in the cylinders, and of the horses-power delivered to the shafting of the factory as determined by a friction brake applied to the engine shaft; but they did not make the most of their opportunity and labour, by ascertaining the condensation of steam in the cylinders and other interesting facts, although the data in their possession would have enabled them to do so with very little additional work. They do not even state the measure of expansion with which the steam was used, nor at what point of the stroke of the pistons the steam was released from and cushioned in the cylinders, though these facts are essential to an understanding of the causes producing the particular results obtained. They do, indeed, give a specimen indicator diagram from each end of the two cylinders for each experiment, from which the reader may ascertain approximately when the steam was cut off, released and cushioned, but they should have given the mean fraction of the stroke of the pistons from all the diagrams, at which these operations upon the steam took place. The back pressures against all the pistons should also have been given, both including and excluding the cushioning, and the back pressure against each piston at the point where the cushioning commenced should have been given. Likewise, the mean pressure of the expanded steam alone should have been given, and the pressure at the end of the stroke of each piston. The omissions mentioned could have readily been supplied from the diagrams in possession of the committee, and always should be in every case of experimenting with steam engines, as without this information only a very imperfect idea can be had of the more or less proper distribution of the pressures in the cylinders, and to what degree the economy of the steam may have thus been affected; a proper experiment and report ascertains and presents the whole subject, nothing is more unsatisfactory than partial data, which may easily lead to erroneous conclusions. Had a drawing been given of the boiler, and had the coal been weighed that was consumed during the long experiments of October 22nd and 23rd, each of over twelve hours' duration, the data of a boiler experiment would have been completed, for all the other quantities are given, and the value of the investigation that much extended. It is true that the coal was weighed during the experiments of July 7th and 8th, but they were entirely too short for reliable vaporisations, being only from three to four hours long.

The report of the committee will be found in the *Bulletin* of the Society for January and February, 1880, pages 5 to 20, in which are detailed the methods of observation and calculation employed, and the results obtained. From this report the following facts have been taken as far as given, and the remainder supplemented from the indicator diagrams above mentioned. No regard has been had to the arrangement, calculations, or inferences of the committee; their observed facts alone have been used. The feed water was carefully measured in a tank before being pumped into the boiler. It was a portion of the water delivered from the jet condenser by the air pumps. The condensing water was also carefully measured in a tank before it entered the jet condenser; and the quantity of combined condensing water and water of steam condensation withdrawn from the condenser by the air pumps was likewise measured in another tank into which it was thrown by these pumps. Indicator diagrams were taken every twenty minutes from each end of each cylinder, and from the mean pressure shown by all of them the indicated horses-power were computed. By a very excellent arrangement of friction brake applied to a drum on the engine shaft, there were ascertained the number of horses-power delivered by the engine to the factory shafting. Of course this power was less than the indicated power by the friction resistance of the engine *per se*, or unloaded, and by the friction of the load on the journals and guides of the working parts of the engine.

The entire work of the engine during the experiments of July 7th and 8th, 1879, consisted in overcoming the friction produced by the brake. During each of these experiments the steam pressure in the boiler was maintained almost without variation, the point at which the steam was cut off in the cylinders remained fixed, and the throttle valve was kept wide open, so that the mean of all the indicator diagrams taken must represent, with absolute accuracy, the mean performance of the engine. The number of double strokes made by the piston of the engine was taken from a counter; and, in the weighing and measuring of the several observed quantities, all the usual corrections were made. The indicators were also carefully measured and tested. A sufficient number of qualified assistants were employed to secure absolute accuracy in the quantities observed.

The data and result of these experiments, made in July, 1879, will be found in the following Table No. 1. In the succeeding October the committee made two additional trials on the engine while doing its regular work at the factory, each of which continued a little over twelve hours, in order to test the accuracy of the July experiments, and to ascertain whether the engine when functioning under the conditions of ordinary practice gave the same economic returns as when tried under the previous experimental conditions. The results of the October tests will be found in the following Table No. 2, which contains all the data taken. Before proceeding to an examination of the tables, it is necessary to have the description and dimensions of the engine given below.

Engine.—The engine is of the portable kind—that is, it is secured upon the top of its boiler, the latter being cylindrical and horizontal, with lugs attached by which it can be placed temporarily on any foundation and readily removed from place to place. The engine works with condensation, and consists of two compounded cylinders of unequal diameters and equal strokes of pistons, lying horizontally side by side and bolted to a strong cast iron bed-plate, which in turn is bolted to the top of the boiler. The cylinders are direct-acting, with piston rods secured into crossheads working between guides, from which crossheads connecting rods extend to the crank pins of the shaft. The shaft is horizontal and curved out into cranks opposite the respective cylinders. It is supported by three pillar blocks, one at each end outside the cranks, and the third midway between the two. One of the projecting ends of the shaft carries the fly-wheel. The excentrics for operating the valves of both cylinders are keyed at proper positions upon the shaft. The valve chest of each cylinder is upon its outer side. The steam valve of the small cylinder is of the usual short slide operated by the usual excentric. In addition to the steam valve, there is an independent slide cut-off valve operated by an excentric, and capable, through suitable mechanism, of varying the point at which the steam is cut off by means of the usual governor acting upon a double cam. When the engine is in operation, the

Table No. I.

Containing the Data and Results of the Experiments made in July, 1879, on a Condensing Compound Engine in the Factory of Antoine Herzog, at Colmar, in Alsace, Germany, by the Committee on Mechanics of the Industrial Society of Mulhouse.

		July 7, 1879. Morning.	July 7, 1879. Afternoon.	July 8, 1879. Morning.	July 8, 1879. Afternoon.
Total quantities.	Duration of the experiments in consecutive hours and decimals of an hour	2·99889	4·00139	3·00222	3·24139
	Total number of double strokes made by the pistons of the engine	16014·	21253·	16211·	17253·
	Total number of pounds of feed-water pumped into the boiler	3950·681370	5378·835048	3248·068561	4265·391060
	Total number of pounds of condensing water admitted to the condenser	73821·492916	98621·255129	74038·567197	78893·841895
	Total number of pounds of condensing water and water of steam condensation withdrawn from the condenser	77872·440202	104133·100378	77253·139183	84499·777450
Engine.	Steam pressure in boiler in pounds per square inch above the atmosphere	91·780	91·524	91·694	92·164
	Pressure in the condenser in pounds per square inch above zero	—	—	1·810	1·907
	Number of double strokes made per minute by the pistons of the engine	89·005187	88·523429	89·994448	88·711972
	Position of the throttle valve	Wide open.	Wide open.	Wide open.	Wide open.
	Fraction completed of the stroke of the piston of the small cylinder when the steam was cut off	0·42	0·42	0·25	0·42
	Fraction completed of the stroke of the piston of the small cylinder when the steam was released	0·98	0·98	0·98	0·98
	Fraction completed of the stroke of the piston of the small cylinder when the steam was cushioned	0·925	0·925	0·925	0·925
	Fraction completed of the stroke of the piston of the large cylinder when the steam was cut off	0·45	0·45	0·45	0·45
	Fraction completed of the stroke of the piston of the large cylinder when the steam was released	0·91	0·91	0·91	0·91
	Fraction completed of the stroke of the piston of the large cylinder when the steam was cushioned	0·75	0·75	0·75	0·75
	Number of times the steam was expanded	6·2569	6·2569	9·6444	6·2569
	Atmospheric pressure in pounds per square inch above zero	14·222813	14·222813	14·222813	14·222813
Water.	Number of pounds of feed-water pumped into the boiler per hour	1317·381221	1344·241638	1081·888022	1315·914179
	Number of pounds of condensing water admitted to the condenser per hour	24616·272326	24646·749012	24661·273057	24648·018873
	Temperature in degs. Fah. of the condensing water when admitted to the condenser	48·256	48·056	48·001	48·010
	Number of pounds of condensing water and water of steam condensation withdrawn from the condenser per hour	25967·087890	26024·231674	25732·004711	26068·994305
	Temperature in degs. Fah. of the condensing water and water of steam condensation when taken from condenser	95·720	97·655	86·932	96·728
	Number of Fahrenheit units of heat consumed per hour	1474655·460688	1502043·606320	1220557·870799	1471790·924665
Steam pressures in small cylinder per indicator.	Pressure on piston of small cylinder at commencement of its stroke, in pounds per square inch above zero	100·768628	102·475366	99·787254	102·966053
	Pressure on piston of small cylinder at point of cutting off the steam, in pounds per square inch above zero	89·262373	90·969111	88·280999	91·459798
	Pressure on piston of small cylinder at the end of its stroke, in pounds per square inch above zero	44·098469	44·941652	33·423600	45·184067
	Mean back pressure against piston of small cylinder during its stroke, in pounds per square inch above zero	45·333226	46·200018	35·343690	46·449021
	Back pressure against piston of small cylinder at the point where the cushioning began, in pounds per square inch above zero	41·590000	42·385000	34·846000	42·614000
	Indicated pressure on the piston of the small cylinder, in pounds per sq. in.	30·200448	30·806612	27·855379	30·673629
	Net pressure on the piston of the small cylinder, in pounds per sq. in.	26·572993	27·179157	24·227924	27·046174
	Total pressure on the piston of the small cylinder, in pounds per sq. in.	71·825000	73·200000	60·200000	73·300000
Steam pressures in large cylinder per indicator.	Pressure on piston of large cylinder at commencement of its stroke, in pounds per square inch above zero	43·000000	43·150000	34·490000	43·200000
	Pressure on piston of large cylinder at point of cutting off the steam, in pounds per square inch above zero	27·540000	27·670000	21·156000	27·740000
	Pressure on piston of large cylinder at the end of its stroke, in pounds per square inch above zero	12·470000	12·529000	9·600000	12·561000
	Mean back pressure against piston of large cylinder during its stroke, in pounds per square inch above zero	3·756000	3·756000	3·756000	3·756000
	Back pressure against piston of large cylinder at the point where the cushioning began, in pounds per square inch above zero	2·355000	2·355000	2·355000	2·355000
	Indicated pressure on the piston of the large cylinder, in pounds per sq. in.	22·100000	22·260000	17·006220	22·300000
	Net pressure on the piston of the large cylinder, in pounds per sq. in.	20·841053	21·001053	15·747273	21·041053
	Total pressure, in pounds per sq. in. above zero, on the annular surface of the piston of the large cylinder remaining after subtracting from the area of that piston the area of the piston of the small cylinder	24·650000	24·810000	19·556220	24·850000
Horse-power.	Indicated horse-power developed in the small cylinder	24·807987	25·168943	23·135064	25·113672
	Net horse-power developed in the small cylinder	21·828234	22·205320	20·123093	22·143736
	Total horse-power developed in the small cylinder	59·000239	59·804261	50·000578	60·013510
	Total H.P. developed in the small cylinder by the expanded steam alone	27·966070	28·349834	28·101654	28·560045
	Indicated horse-power developed in the large cylinder	52·358337	52·451950	40·738193	52·658120
	Net horse-power developed in the large cylinder	49·375696	49·485453	37·722401	49·685305
	Total horse-power developed in the large cylinder by the annular surface of its piston remaining after subtracting from the area of that piston the area of the piston of the small cylinder	38·150181	38·190874	30·603792	38·333920
	Total H.P. developed in the large cylinder by the expanded steam alone	40·017681	40·047311	32·491077	40·194311
	Aggregate indicated horse-power developed by the engine	77·166324	77·620893	63·874157	77·771792
	Aggregate net horse-power developed by the engine	71·203930	71·690773	57·845494	71·829041
	Aggregate total H.P. developed by the engine, exclusive of cushioning	97·151320	97·995135	80·604370	98·347430
	Aggregate total horse-power developed by the expanded steam alone in both cylinders, inclusive of cushioning	67·983751	68·397145	60·592731	68·754356
	Horse-power developed by the engine at the friction brake applied to the wheel on the engine shaft	67·690889	67·524224	55·717593	67·499569
	Percentum of the total horse-power developed by the engine utilised as indicated horse-power	79·42900	79·20892	79·24403	79·07862
	Percentum of the total horse-power developed by the engine utilised as net horse-power	73·29177	73·15748	71·76471	73·03601
	Percentum of the total horse-power developed by the engine utilised as horse-power at the friction brake	69·67572	68·90569	69·12477	68·63379
Economic results.	Number of pounds of feed-water consumed per hour per indicated H.P.	17·071971	17·318039	16·937819	16·920199
	Number of pounds of feed-water consumed per hour per net H.P.	18·501524	18·750553	18·703080	18·320085
	Number of pounds of feed-water consumed per hour per total horse-power developed by the engine	13·560096	13·717432	13·422212	13·380260
	Number of pounds of feed-water consumed per hour per horse-power developed by the engine at the brake	19·461721	19·907547	19·417366	19·495149
	Number of Fah. units of heat consumed per hour per indicated H.P.	19110·09083	19351·023136	19108·790286	18924·482602
	Number of Fah. units of heat consumed per hour per net H.P.	20710·309960	20951·701781	21100·310264	20490·193161
	Number of Fah. units of heat consumed per hour per total horse-power developed by the engine	15178·954446	15327·737406	15142·576895	14965·219982
	Number of Fah. units of heat consumed per hour per horse-power developed by the engine at the brake	21785·139514	21960·619794	21906·148580	21801·449220
Weight of steam accounted for by the indicator.	Number of pounds of steam present per hour in the small cylinder at the point of cutting off the steam, calculated from the pressure there	987·257750	998·747724	607·871477	1005·726509
	Number of pounds of steam present per hour in the small cylinder at the end of the stroke of its piston, calculated from the pressure there	1148·026328	1162·498768	879·050774	1170·906554
	Number of pounds of steam condensed per hour in the small cylinder to furnish the heat transmuted into the total horse-power developed by the expanded steam alone in that cylinder	77·162184	78·298208	76·530424	78·900853
	Sum of the two immediately preceding quantities	1225·188512	1240·796976	955·581198	1249·807407
	Number of pounds of steam present per hour in the large cylinder at the end of the stroke of its piston, calculated from the pressure there	1043·182517	1042·551556	805·905933	1047·498116
	Number of pounds of steam condensed per hour in the small and large cylinders, and in the receiver to furnish the heat transmuted into the total horse-power developed in those cylinders by the expanded steam alone after the closing of the cut-off valve on the small cylinder	183·285887	184·699591	162·065479	185·699642
	Sum of the two immediately preceding quantities	1226·468404	1227·251147	968·061412	1233·197758
Difference between the weight of water vaporised in the boiler and the weight of steam accounted for by the indicator.	Difference in pounds per hour, between the weight of water vaporised in the boiler and the weight of steam accounted for by the indicator in the small cylinder at the point of cutting off the steam	330·123471	345·493914	474·017445	310·187670
	Difference in percentum of the weight of water vaporised in the boiler, between that weight and the weight of steam accounted for by the indicator in the small cylinder at the point of cutting off the steam	25·059069	25·701771	43·813874	23·572020
	Difference in pounds per hour, between the weight of water vaporised in the boiler and the weight of steam accounted for by the indicator in the small cylinder at the end of the stroke of its piston	92·192709	103·444662	126·307724	66·106772
	Difference in percentum of the weight of water vaporised in the boiler, between that weight and the weight of steam accounted for by the indicator in the small cylinder at the end of the stroke of its piston	6·998180	7·695392	11·674740	5·023638
	Difference in pounds per hour, between the weight of water vaporised in the boiler and the weight of steam accounted for by the indicator in the large cylinder at the end of the stroke of its piston	90·912817	116·990491	113·827510	82·716421
	Difference in percentum of the weight of water vaporised in the boiler, between that weight and the weight of steam accounted for by the indicator in the large cylinder at the end of the stroke of its piston	6·901026	8·703085	10·521183	6·285852
Cylinder pressures reduced to large cylinder alone.	Indicated pressure, in pounds per square inch, that would be on the piston of the large cylinder were the indicated pressure on the piston of the small cylinder divided by the ratio of the area of the small to that of the large cylinder, and the quotient added to the experimental indicated pressure on the piston of the large cylinder	32·571236	32·941408	26·664363	32·935300
	Net pressure in pounds per square inch, that would be on the piston of the large cylinder, similarly calculated to the immediately above	30·054561	30·424733	24·147684	30·418625
	Total pressure, in pounds per square inch above zero, that would be on the piston of the large cylinder, corresponding to the total horse-power developed by the engine	41·006728	41·587998	33·648414	41·648801
	Back pressure, in pounds per sq. in. above zero, that would be against the piston of the large cylinder similarly calculated to the above	8·435492	8·646590	6·934051	8·713501

point of cutting off automatically varies with the variations of the load. The large cylinder has no independent cut-off valve; its steam valve is the usual short slide operated by the usual excentric. The steam is cut off, however, at an invariable point in the large cylinder, by means of lap on the steam side of the steam valve. The valves of neither cylinder were counterbalanced, but worked with the full valve chest pressure upon their backs. As the load of the engine during the experiments of July 7th and 8th, hereinafter described, consisted entirely of friction produced by a brake carrying the weight always at the same leverage, which weight was the same for all the experiments except that of the morning of July 8th, in which it was reduced nearly one-half, the point of cutting-off in the small cylinder remained invariable throughout each experiment. For the experiment of the morning of July 8th, the steam was cut off in the small cylinder at 0·25 of its stroke from the commencement, and for the remaining experiments at 0·42 of its stroke. The steam in all the experiments was released from the small cylinder when 0·98 of the stroke of its piston was completed, and cushioned when 0·925 of the return stroke was completed. The point of cutting in the large cylinder, during the above-mentioned experiments, was when 0·45 of the stroke of the piston was completed. The steam was invariably released from the large cylinder when 0·91 of the stroke of its piston was completed, and cushioned when 0·75 of the return stroke was completed. The small cylinder has a steam jacket covering its entire cylindrical surface, the jacket being interposed between the cylinder and the valve chest. By this arrangement the bottom of the valve chest becomes steam jacketted, which is advantageous to the economy, but the steam passages are lengthened by the width of the jacket, which is advantageous to a much greater degree. The ends of the cylinder are not jacketted. The exhaust steam from the small cylinder contours the upper part of the outside of the jacket of that cylinder, taking heat from the jacket, and is delivered to the steam valve of the large cylinder, after traversing a passage or jacket contouring the upper part of the large cylinder to its valve chest. The lower part of the large cylinder, excepting the surface covered by its valve chest, has a steam jacket, which receives its steam directly from the boiler. Only one-half of the cylindrical surface of the large cylinder is jacketted with steam taken immediately from the boiler. The remainder of this surface is covered by the valve chest and by the exhaust passage leading to it from the small cylinder. The valve chest of the large cylinder is cast upon the cylinder itself, the side of which forms the bottom of the chest, so that no jacket space interposes between them, as in the case of the small cylinder. Neither end of the large cylinder is jacketted. There is no separate steam pipe leading from the boiler to the jackets of the cylinders. The main steam pipe delivers the boiler steam into the jacket of the small cylinder a little above the lowest point of that jacket. This pipe has an inclination downwards to the boiler, made in the expectation that the water of condensation from the jackets would drain back by gravity to the boiler. From the jacket the steam enters the small cylinder. The steam jacket of the large cylinder, receiving its steam directly from the boiler, is supplied through a short branch from the main steam pipe, which branch enters that jacket a little above its lowest point.

To resume: Both the heads of both cylinders are not steam jacketted. The entire cylindrical surface of the small cylinder and one-half of this surface of the large cylinder are steam jacketted. The remaining half of the cylindrical surface of the large cylinder is covered by its valve chest and by the exhaust passage leading to it from the small cylinder. The exterior surfaces of the cylinders, with the exception of the heads, are clad with non-heat-conducting substances. There are two air pumps, worked by a T-lever, actuated by a short connecting-rod, articulated to the crosshead. These pumps are vertical and immersed in a tank. The feed pump is articulated to one of the arms of the lever working the air pumps. There is one jet condenser of very great capacity relatively to the volume of the large cylinder. The injection water is sprayed into it by a conical rose. The speed of the engine is automatically regulated by a Porter governor acting on the cut-off cam by means of the Denis compensator, an apparatus that Messieurs Weyher and Richemond apply to nearly all their engines with excellent results. The following are the dimensions of the engine:—

Diameter of the small cylinder	11·2010	in.
Diameter of the piston rod of the small cylinder ..	2·1654	in.
Stroke of the piston of the small cylinder	18·8980	in.
Net area of the small cylinder piston	96·696816	sq. in.
Space displacement of the small cylinder piston, per stroke	1·0575095	cub. ft.
Space in clearance and steam passage at one end of small cylinder	0·0676805	cub. ft.
Per centum which the space in clearance and steam passage at one end of the small cylinder is of the space displacement of its piston per stroke	6·40	
Length of the steam port of the small cylinder ..	4·7245	in.
Breadth of the steam port of the small cylinder..	0 9843	in.
Area of the steam port of the small cylinder.. ..	4·6503	sq. in.
Diameter of the steam pipe	3·1497	in.
Depth of the piston of the small cylinder	4·7245	in.
Diameter of the large cylinder	18·9059	in.
Diameter of the piston rod of the large cylinder ..	2·1654	in.
Stroke of the piston of the large cylinder	18·8980	in.
Net area of the large cylinder piston..	278·886568	sq. in.
Space displacement of the large cylinder piston per stroke	3·0499990	cub. ft.
Space in clearance and steam passage at one end of large cylinder	0·1525010	cub. ft.
Per centum which the space in clearance and steam passage at one end of the large cylinder is of the space displacement of its piston per stroke	5·00	
Length of steam port of large cylinder	9·4490	in.
Breadth of steam port of large cylinder	0·9843	in.
Area of steam port of large cylinder	9·3006	sq. in.
Diameter of the exhaust pipe	4·5000	in.
Depth of the piston of the large cylinder..	4·7245	in.
Distance between the axes of the two cylinders ..	23·6225	in.
Thickness of metal of the two cylinders	0·9843	in.
Area of the piston of the large cylinder relatively to the area of the piston of the small cylinder taken as unity	2·884134	
Aggregate space displacement of the piston of the large cylinder per stroke, and space in clearance and steam passage at one end of that cylinder, relatively to the aggregate space displacement of of the piston of the small cylinder per stroke, and space in clearance and steam passage at one end of that cylinder taken as unity	2·846186	

Table No. 1 contains all the observed quantities, and the calculated results from them, obtained during the special July trials of the engine. These quantities and results are arranged in groups for facility of reference. Each quantity and each result is so fully described on the line bearing it, that only in a few cases is any further explanation necessary. The experiments were four in number, and were made with nearly the same piston speed in all, the difference being too small to exercise any practical effect on the economic result. The boiler pressure and the condenser pressure also varied but very little during the different experiments, and the throttle valve was kept wide open in all, so that as regards these important conditions, all the experiments had equality, being made with equal boiler pressure, equal piston speed, equal throttle valve opening, and equal condenser pressure. During all the experiments, except that of the morning of July 8th, the distribution of the steam was exactly the same, being cut off in the small cylinder when 0·42 of the stroke of its piston was completed, and in the large cylinder when 0·45 of the stroke of its piston was completed, the measure of expansion with which the steam was used being, by volume, 6·2569 times in all three experiments. For the small cylinder, the steam was released when 0·98 of the stroke of its piston was completed, and for the large cylinder when 0·91 of the stroke of its piston was completed. In the small cylinder, the cushioning of the back-pressure steam commenced when 0·925 of the return or exhaust stroke of the piston was completed, and in the large cylinder when 0·75 of that stroke of its piston was completed. The three experiments, therefore, of the morning and afternoon of July 7th, and the afternoon of July 8th, were repetitional in order to secure certainty of the result on which the award of the prize was to depend. In the single experiment of the morning of July 8th, the distribution of the steam in the large cylinder was exactly the same as in the case of the three other experiments; but, in the small cylinder, the steam was cut off when 0·25 of the stroke of its piston was completed, the release and the cushioning being the same as in the three other experiments. Thus the only difference was the changing of the point of cut-off in the small cylinder from 0·42 to 0·25 of the stroke of its piston from the commencement, whereby the measure of expansion with which the steam was used was made 9·6444 times by volume. The experiments, therefore, enable the determination to be made under equal and unexceptional conditions, and with extreme accuracy, of the economic results due to working high-pressure steam in the partially steam jacketted cylinders of a condensing compound engine with pistons moving at a high reciprocating speed, with the measures of expansion 6·2569 and 9·6444 times, by volume. The results are very valuable and far reaching in engineering, and engineers should give them careful consideration and frank acceptance. The number of pounds of feed water pumped into the boiler, the number of pounds of condensing water admitted to the condenser, and the number of pounds of condensing water and water of condensation withdrawn from the condenser, were obtained by separate measurements in different vessels, and are therefore three independent determinations. The last measurement should give the sum of the two previous ones, and it does so very nearly, the difference being of no practical importance. The very close approximation, however shows the extreme care taken in the measurements.

(*To be continued.*)

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, September 19th.

There are indications in political circles of the probability of a severe contest on the silver question. The Administration is preparing to take an active part in the struggle. The Congressional Committees are already being arranged with the view of suspending silver coinage. A bitter contest will result, as the silver party is influential and determined. The industrial activity noted recently continues in all sections of the country. Retailers and jobbers are placing large orders for merchandise of all kinds for early delivery. The boot and shoe industry is particularly active. The shipments this year are heavier than last. The textile manufacturers are crowded with orders, and within the past week a considerable number resumed night work. The clothing manufacturers are making extensive shipments throughout the south and west, and are running their establishments full time. An increase of work is reported at all leading foundries and machine shops in New England and the Middle States. The activity in progress is of a compensating character, due to the extreme dulness of the summer. As yet but very little business is done for future requirements. Until demand assumes this characteristic, no upward tendency in prices will be possible. Manufacturers and jobbers of all kinds are too anxious for business to attempt higher prices, and until there are indications of an upward tendency, consumers throughout the country will not order more goods than are needed for immediate distribution and consumption.

The iron industry is without any particular improvement. A steady demand continues in all branches, and it is thought in well informed circles that when requirements for three or four months are covered, that the present rush of orders will fall off. Steel rails are selling at 29 dols. at mill, and very little capacity remains to be sold up to the end of the year. The steel mills are well supplied with orders. The sheet and plate mills have secured encouraging business. The pipe makers are crowded night and day. The blast furnace industry is dragging. A slight attempt was made to advance prices, but it has failed. Several inquiries are in the hands of brokers this week for Scotch and Bessemer irons. Spiegeleisen is also wanted, and prices have been advanced to 26 dols. Very little foreign material is arriving, and it is not probable that at present prices orders will be placed. American Bessemer is selling at 15 dols. to 18 dols., according to quality. Railroad requirements are still held back, excepting for cars. Within thirty days the business of the car works has been increased 25 per cent.

In financial circles money is abundant, and the rate of interest low. A large amount of money is seeking employment. In commercial circles the volume of business is slowly increasing, but the list of weekly failures is not declining.

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

(*From our own Correspondent.*)

Business in iron this week is much on all fours with its condition a week ago. We are nearer the quarterly meetings, which will take place next Wednesday and Thursday in Wolverhampton and Birmingham respectively, and buyers are postponing business. The meetings are likely to be attended by large numbers of traders from all parts of the kingdom.

There is no lessening of activities at the sheet works, and numbers of the mills now commence the week in earnest on Monday nights. Certain firms stated to-day—Thursday—that their out-turn this month will total larger than any previous month this year. Prices keep firm at £7 2s. 6d. to £7 5s. for 24 gauge, and £8 2s. 6d. to £8 5s. for 27 gauge.

Galvanisers continue well engaged, and a few exceptional firms boasted this afternoon that they were under no necessity to book any more orders this side of Christmas. Quotations stand at £11 to £12 f.o.b. delivered Liverpool.

The quotation of £7 10s. for marked bars is being upheld, medium qualities can be bought for £6 10s., whilst in common sorts £5 10s. to £5 7s. 6d. is the price quoted.

Messrs. Hingley and Sons are receiving brisk orders for best bars from Australia, and some orders also from the United States. The foregoing quotation is £7 to £7 10s. Earl Dudley's bars are £8 2s. 6d. lowest quality, £9 10s. single best, £11, double best and £13 treble best. His lordship's rivet and tee iron is £10 10s. single best, £12 double best, and £14 treble best; common tee iron, £9 2s. 6d.

Ordinary sizes of merchant iron are in pretty good request; shoe and tire iron continues in fair sale. Rivet iron is in somewhat increased request, especially in the best qualities. Common hoops are £5 10s., and superior £6 to £6 10s. Gas tube strip is £5 5s. to £5 7s. 6d.

Steel plating bars continue to be offered to edge tool makers in great variety. The younger steel making districts, particularly South Wales, are competing earnestly with the Sheffield houses. The quality of much of the mild steel offered is so excellent that crucible steel, once considered indispensable for plating purposes, has now been largely knocked out of the market.

The Patent Shaft and Axletree Company, Wednesbury, are producing splendid steel of this description. The price is about £6 per ton, and £6 to £6 5s. is the figure also for reliable plating bars imported from other districts. Some tool firms are paying £7 5s. for their supplies, which they believe come from Sheffield; but I have reason to understand that the steel supplied is not all Sheffield make. Common plating bars are £5 12s. 6d. down to £5 10s.; but they are not of much service. Bessemer billets are abundant at £4 17s. 6d.

In pig iron there are continued inquiries as to prices in view of the arrangement of deliveries for another quarter. But most of the business of this sort has been concluded during the past few weeks, heavy sales having occurred. Hematite pigs are the strongest upon the market, 53s. to 54s. being quoted for best forge sorts from the west coast. All-mine pigs are quoted 57s. 6d. to 60s.; part mines, 40s. to 42s.; and cinder pigs, 32s. 6d. to 35s. Derbyshire's are 39s. to 40s.

The Haybridge Iron Company, Wellington, Salop, has just taken over the adjoining Old Park Ironworks, which have been standing for several years. The works comprise three blast furnaces and colliery areas.

Steel masters are interested that the North-Eastern Railway Company should have issued tenders for from 10,000 to 20,000 tons of rails; but rail making has not been commenced in this part of the kingdom, nor so long as the tendency is to establish works upon the coast is there any probability of the manufacture being taken up here. Manufacturers who are expecting to benefit from the construction of the Indian railways, and possibly also from the construction of the Chinese lines, remark this week that they would be very gratified if the suggestion which has been thrown out, that lines should be constructed in western and other parts of Australia with English capital, were to be taken up with earnestness. Work is still coming out from the Indian railway companies.

Merchants and manufacturers doing business with Australia still speak of the injury to profitable trade which is being done by the consignment system. Perfect hardwares are every week going off in the Australian sale rooms at lower prices than can be charged for the same wares at manufacturer's own doors.

Cultivating tool manufacturers are receiving heavy inquiries by every mail. Indian buyers are unable to satisfy their necessities fast enough.

The new traffic arrangement by which all the Midland trains from Liverpool, Manchester, and the North to Bristol and the West of England, and *vice versâ*, will run through New-street Station, Birmingham, *viâ* the new west suburban extension to King's Norton, where they will join the main line, came into operation yesterday —Thursday.

Plans and estimates have been prepared for a new drainage scheme for Tipton, since the local authorities are threatened with proceedings by the Corporation of Birmingham. The estimated cost is £35,000. The Board, however, has received the estimate with disfavour, and has referred it to the general purposes committee.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—A general lull has again settled over business in the iron trade of this district. To some extent buying may be held in suspense pending the quarterly meetings, the prospects for which are certainly less favourable than they were a week or two back, but the real cause of the resumed quietude in the market is the absence of requirements, or of any improvement in the iron-using branches of industry to warrant consumers in buying at all largely. Prices show no appreciable giving way, as makers of pig iron, being in no immediate want of orders, are not at all anxious to press sales; whilst finished ironworks are generally moderately well supplied with orders, some of the large works being rather under pressure to complete deliveries for shipment, and although no actual advance has been established in manufactured iron, prices are very firm at late quoted rates.

The Manchester iron market on Tuesday again brought together a full attendance, but business was very slow. For pig iron especially there was very little inquiry, except that in some instances buyers are prepared to give out orders for next year's delivery at present rates, but these makers decline to entertain. Lancashire pig iron makers, who have their books pretty full for the present, are very firm at 39s. for forge and 39s. 6d. for foundry, less 2½, delivered equal to Manchester, and about these figures also remain the minimum prices quoted for district brands. A rather weaker tone is, however, shown in outside brands, but it is still difficult to get anything like good brands of foundry Middlesbrough at under 41s. 4d. to 41s. 10d., net cash, delivered equal to Manchester.

For hematites the demand continues very slow, and prices remain at about 52s. to 52s. 6d., less 2½, for good foundry qualities delivered into this district.

In manufactured iron new business is coming forward only very slowly, and it is exceptional where makers, although fairly busy for the present, have any great weight of work ahead. Prices are firm at £5 5s. for bars, £5 15s. for hoops, and £6 15s. to £6 17s. 6d. per ton for local-made sheets delivered into the Manchester district.

Although many of the engineering firms in this district are kept busy with present orders, or on specialities, the general complaint is still made that the weight of new work coming forward, or in prospect, is very small. The monthly report of the Steam Engine Makers' Society, just issued, returns the condition of trade as slightly worse, if anything—certainly without improvement. In some of the Lancashire districts especially, such as Bolton, Wigan, and Blackburn, there has been a decline; in Manchester and Salford trade is only moderate; with Bury, Oldham, and Rochdale fairly employed. The small engine building trades are only indifferently supplied with orders, and the large engineering works are slack, especially those really dependent upon the iron and coal industries, and in some of the tool shops trade is slackening off. The returns as to employment show an increasing call upon the Society's funds for out-of-work donation, the number of members on the books being about 5 per cent., as compared with 4 per cent. a couple of months back. To some extent this increase is due to the recent strike at Sir William Armstrong's works, and the fire at the Barrow works, which together have thrown a considerable number of men upon the books.

Railway works in Japan, I hear, are being pushed forward vigorously; I have previously referred to orders for tools that are being executed for Japanese workshops, and several orders for the Imperial Railways of Japan have recently been given out to Slack's Emery Wheel and Machine Company, Manchester, who have supplied one of their tool grinders for engineers' purposes, which was awarded a silver medal at the Inventions Exhibition, and also one of their Universal grinding machines for workshop purposes. The above company have also just brought out a new saw sharpening machine, specially designed for colonial use, and to compete with the cheap American machines which are sent into the colonial markets, the main features of the new machine being lightness of construction and absence, as much as possible, of any complication of the working parts.

In telephone work I may mention, as something of a novelty, that Messrs. W. T. Glover and Co., of Salford, have on hand several of the new anti-induction cables for 100 wires each, and they are also constructing a field telephone plant for military purposes, the wires of which are so exceptionally light and flexible that a length of about two miles can be carried on a special reel by one man.

Another noticeable item in connection with the development of electrical appliances is the opening this week of the electrical tramway at Blackpool, and the working of this line, which, so far, is the most important application yet made of electricity as a motive power on tramways, will be watched with considerable interest.

In the coal trade the month has opened with an upward movement in prices so far as the better qualities of round coal for house fire purposes are concerned, and in anticipation of this there has been rather a push of orders during the past week. Other classes of fuel are, however, without improvement either in price or demand, common round coals being still in very poor demand for iron-making and steam purposes, whilst engine classes of fuel continue a drug in the market. The advance on house coals averages 10d. per ton on the delivered rates in the Manchester district, and about 6d. per ton on the pit prices of the South-West Lancashire districts, best coal at the pit now being quoted at 9s., with seconds house coal ranging from 7s. to 8s., according to quality; but common round coals can still be got at 5s. to 5s. 6d., burgy at 4s. 3d. to 4s. 9d., good qualities of slack at 3s. 6d. to 3s. 9d., and common sorts at from 2s. 3d. and 2s. 6d. per ton upwards.

The men have not been slow to take advantage of any upward movement in prices, and the Lancashire Miners' Federation has sent out circulars to all the colliery owners in the district requesting an advance in wages of 15 per cent.

Barrow.—There is no change to note in the condition of the hematite pig iron trade, but the firmer tone noted last week in the demand for hematite pig iron is fairly maintained, and the improvement which has taken place in the American market is also shown here. There is undoubtedly a growing feeling of confidence, and although for the moment it is impossible to see how any very greatly improved trade can possibly be realised during the winter months, there are not wanting evidences that the market has reached a low point, from which it is impossible to go lower, and at which, if no special circumstances intervene to bring about further improvements, trade may be expected to stand for some time. The fact is that the downward tendency has had a check, and it is believed and hoped that a better demand will soon set in, and that a brighter winter than what was expected will lead to a much more active state of things next summer. The value of Bessemer iron remains steady, but very firm at 42s. 6d. per ton net at makers' works for mixed parcels, with 1s. per ton extra for forward deliveries. Forge and foundry iron is quoted at 41s. 6d. per ton, but there is very little trade in any quality of iron which has to be used for general purposes. Steel makers are indifferently employed. There is very little trade being done by makers of steel rails or plates, and the trade being done in general samples of steel is greatly restricted. Wire, hoops, billets, &c., are in small demand, and the mills in the district are poorly employed. Steel wire nails are being largely produced in the district, and an improvement in trade in this direction is expected. The shipbuilding trade is indifferently employed, and no new orders are coming to hand. Inquiries are very scarce, and they are competed for with considerable spirit on all hands. Iron ore finds a very poor market. Engineers are better employed owing to the urgency of completing several contracts in the hands of the Barrow Shipbuilding Company, whose engineering shop was destroyed by fire a few weeks ago. Ironfounders and boiler-makers are not doing much new business. Coal and coke is quieter. The shipping is for the moment rather better employed.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

What has been anticipated and dreaded for a considerable time has now come to pass. The conference of delegates representing the miners of Yorkshire, Lancashire, North and South Staffordshire, Cheshire, East Worcestershire, and Nottinghamshire, meeting at Nottingham, have decided upon reviving the question of an increase in colliers' wages. This, of course, was the natural outcome of the preliminary conference held at Manchester, which was the first indication of disturbance ahead. At Nottingham the conference was conducted with closed doors, but the results of the deliberations were afterwards communicated. It was stated that the delegates had received and considered reports as to the condition of trade and the rate of wages prevailing in each district. The reports were generally to the effect that trade was greatly improved, that the wages now being paid were quite inadequate for the needs of the mining community, and that the time was opportune for an advance of wages being conceded by the masters. On the strength of these reports a resolution was carried to the effect "that the conference decided that every county and district represented should seek an advance of 15 per cent. on the present rate of wages." The usual course will be taken to put this resolution in force—that is to say, application will be made to employers in each district for the advance, and a conference will take place on the 15th October, at Manchester, to receive and consider reports of results. The delegates are said to have been generally in favour of some regulation of the output, and one or two were extreme enough to recommend that the whole mining community should be laid idle in order to obtain an increase in the value of coal, which would justify the employers in at once conceding the full 15 per cent. There was, however, a pretty strong leaven of common sense in the conference which advocated a peaceful settlement and an avoidance, if possible, of all rupture with the masters. It is earnestly to be hoped that no extreme course will be taken in the present state of trade. Coalowners are just beginning to feel the benefit of the winter demand, and the miners are thus securing increased employment. With patience and forbearance on both sides, and a resolute determination not to hazard the coal industry by another disaster in the form of a lock-out or a strike, more benefit will accrue to both capital and labour than by any compulsory attempt to force up values.

So far I can hear very little of the advance in the prices of iron to justify the reported revival, and of which so much is rumoured from the Scotch, Middlesbrough, and Birmingham districts. An improvement in the price of hematites in one or two districts has certainly not extended to Sheffield, hematites here being still quoted, Nos. 1, 2, and 3, at 49s. to 50s. Pig iron can still be bought in any quantity at the old figures. Lancashire pig, which for some purposes is largely used in South Yorkshire, is at 36s. to 42s. for foundry, and from 33s. to 34s. for forge. Derbyshire foundry pigs are about the same as forge pigs running from 34s. to 38s. The manufactured iron trade shows little variation, angles according to quality, from £6 to £7 5s.; bars from £5 2s. 6d.; hoops, from £5 10s.; sheets, from £6 15s., and T iron, from £6 upwards, at the works. Foundries engaged upon colliery specialities are fairly busy, but others on railway and general work are but indifferently employed.

The North-Eastern Railway Company has decided on relaying part of its lines, and is now asking tenders for about 20,000 tons of steel rails. Our local firms are not likely to have much chance in the competition, as Messrs. Bolckow, Vaughan, and Co. are advantageously located close to the North-Eastern Railway system. Messrs. Chas. Cammell and Co., Cyclops Works, have now on wagons at Penistone a large quantity of rails for inland companies. As a rule, the rail trade continues very light, and I hear that the firms at the coast are making complaints of the scarcity of orders for export. British East Indies and British North America are considerably increasing as markets for railroad material.

American correspondents writing to local newspapers report that the Southern buyers have recently given an impetus to the English cutlery and hardware business out there. The southern part of the country is said to be in a prosperous condition, the people being more hopeful than at any time since the war, this hopefulness being founded on abundant crops and the extension of various profitable enterprises by the aid of northern capital. On the other hand, I find that the houses are not confident that the revival in America is real. The larger orders are regarded as little more than the usual increase of business preparing for the fall and winter trade. It is admitted, however, that failures are diminishing, prices getting firmer, stocks of goods becoming reduced, and generally more confidence prevailing, all of which are signs of a better state of things. One correspondent, I notice, touches upon an old difficulty. Several buyers tell Sheffield agents that in some goods, particularly scissors, they are compelled to prefer the German manufacturers in consequence of their superior finish. "If one of your cutlers," says the writer, "will purchase a line of German scissors of low and middle qualities, he will see how true is all that I have said about superior finish." In high-class goods Sheffield manufacturers have always retained their supremacy, but this complaint of inattention to styles and adherence to old ways is quite an old grievance against local establishments, and in these days of waning markets and keen competition, it is surely time that we heard the last of the superiority of German goods in all classes of cutlery.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

Very little business was done in Cleveland pig iron during last week, and at the market held at Middlesbrough on Tuesday the tone was flat, and prices were about 3d. per ton lower. Merchants' quotations for No. 3 g.m.b. for prompt delivery was 32s. 6d. per ton, but only small lots were sold, as buyers are holding off now that prices are receding. Makers do not accept this price, but remain firm at the same figures as were quoted last week. Forge iron also was weaker, sales being made at 31s. 6d. per ton.

Small holders of warrants are eagerly selling out at 33s. 6d. per ton, but large holders are not anxious to sell, and do not quote under 33s. 9d.

The stock in Connal and Co.'s Middlesbrough store amounted on Monday last to 99,163 tons, being an increase of 4803 tons for the week. At the beginning of June this stock was about 50,000 tons.

Shipments of pig iron are steady, and very satisfactory. Up to Monday night the quantity sent away this month was 80,937 tons, against 71,810 tons during the same portion of August.

There is nothing new to be said with regard to the finished iron trade. Orders are as scarce as ever, and though makers have to pay slightly higher prices for their raw material, they do not get more for finished iron. Prices are the same as quoted for some time past.

The "newspaper boom" has certainly passed off for the present. Pig iron is half-way back from the highest to the lowest level it has recently reached, and the value of North-Eastern Consols, which may be taken as a representative railway stock, has sunk in about the same proportion. As regards finished iron, Mr. Waterhouse's returns for July and August show a reduction in volume, but a slight increase in average realised price. At first sight this seems anomalous; but on closer inspection it will be found that more has been turned out in the form of bars, and less in the form of angles, than in the previous period; and as bars are to a larger extent ordered of higher qualities at higher prices than angles are, it follows that the general average is slightly raised. Indeed, the value of finished iron of any particular kind has not risen, but has fallen; but the consumption of the more costly kinds has somewhat increased, and that of the less costly kinds has more than proportionately diminished. These are some of the facts which are kept in view by members of the iron trade in Cleveland, and which tend to keep alive desponding ideas.

Meanwhile Mr. J. M. Swank, of the American Iron and Steel Association, has favoured the world with his views, and they certainly tend in an opposite direction. Mr. Swank deliberately, and *ex cathedra*, says that "general business is surely improving from day to day in the States. The better feeling is largely due to the more hopeful outlook which exists in railroad circles. Trunk line difficulties are being settled; prices of goods have fallen so low that they could not fall lower; and business men finding this out, are giving larger orders than they were; and in the time of trial of the last year or two there has been economy in use and 'pinchings,' which now have created a necessity, compelling users to buy more largely. Railroad companies, users of machinery, and other large consumers have economised until they can economise no longer. The South is more prosperous; the cotton crop is good; manufacturers of textile machinery are better employed, and agricultural machinery is more in demand. Best grades of foundry and forge pig iron are more in request. Bar iron is firm, plate, sheet, and structural iron are more needed, and steel rails advanced from 27 dols. per ton in July to 30 dols. at the close of August. There is increased confidence. In many instances there are higher prices. Business is better, and in some specialities it is very much better. Thus the tide has turned." Now, if all this is accurate and reliable evidence it is very satisfactory, and we may be certain that a similar state of things will presently supervene here. But if it has been evolved from the inner consciousness of a sanguine temperament, or represents a deliberate attempt on the part of an individual or trade combination to work up their particular interests, then it is misleading and reprehensible, and will certainly not succeed. It is impossible to regard Mr. Swank as a disinterested witness, and therefore his deliverances may very properly be closely examined and criticised. But on the other hand, there is so much probability that they will be criticised by competent critics on the spot, and held up to ridicule if incorrect, that it is scarcely likely that so prominent an oracle would risk his reputation and subject himself to contradiction by saying what he could not prove. So that Mr. Swank's manifesto may be taken as pretty nearly accurate to the extent of his visual horizon; and in that case a renewal before long of the recent spurt in prices may confidently be anticipated in this country.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The warrant market, which had been comparatively firm towards the close of last week, suffered a relapse in the early portion of the present week in consequence of a disposition to sell on the part of holders at a time when there was no special demand. The shipments of pigs in the past week were not unfavourable, amounting as they did to 11,022 tons, as compared with 12,214 in the preceding week, and 9242 tons in the corresponding week of 1884. The exports to Canada and Russia exhibit an improvement, but the demand from other places is quiet. The week's addition to stocks in Messrs. Connal and Co.'s Glasgow stores is upwards of 1900 tons. There is no alteration in the amount of the output.

Business was done in the warrant market on Friday at 42s. 11d. cash. Monday's market was comparatively firm with transactions between 43s. 0½d. and 42s. 11d. A considerable amount of warrants having been thrown on the market on Tuesday, business took place in the forenoon down to 42s. 8d., and there was a further decline in the afternoon to 42s. 6½d., the closing cash price being 1d. more. On Wednesday transactions took place at 42s. 7d. to 42s. 9d., and back to 42s. 7½d. cash. To-day—Thursday—business was done at 42s. 7d. to 42s. 5d., closing at 42s. 5d. cash.

The market values of makers' iron are:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 47s.; No. 3, 44s.; Coltness, 50s. and 46s.; Langloan, 48s. and 45s.; Summerlee, 48s. 6d. and 44s.; Calder, 52s. and 44s.; Carnbroe, 46s. and 44s.; Clyde, 46s. and 42s.; Monkland, 43s. and 40s. 6d.; Quarter, 43s. and 40s. 6d.; Govan, at Broomielaw, 43s. and 40s. 6d.; Shotts, at Leith, 47s. 6d. and 46s. 6d.; Carron, at Grangemouth, 48s. and 47s.; Kinneil, at Bo'ness, 44s. and 43s.; Glengarnock, at Ardrossan, 46s. 6d. and 42s. 6d.; Eglinton, 42s. 6d. and 39s. 6d.; Dalmellington, 44s. and 41s.

There is a steady consumption of Cleveland pig iron in Scotch foundries and malleable works, and the arrivals of these pigs in Scotland to date amount to 268,318 tons, being 79,445 tons of an increase over the quantity received in the same period of 1884.

The Siemens Steel Works at Dalziel are reported busy, and there appears to be rather more doing in a number of the malleable ironworks of Lanarkshire.

Messrs. Goodwin, of Motherwell, have nearly completed a large iron girder bridge upon which they have been engaged for India.

In the past week there has been shipped from Glasgow machinery to the value of £3300; sewing machines, £2745; steel goods, £2800; and iron manufactures, £31,500, the latter including sleepers, wagons in parts, bars, pipes, and sheets to the value of £10,750 for Bombay, and £5550 worth of pipes for Sydney.

The demand for main coals for shipment at both the Eastern and Western ports of Scotland is still well maintained, although it must slacken soon, owing to the prospective closing of the Northern ports. The shipments from Glasgow in the past week were 23,475 tons; Grangemouth, 18,417; Troon, 7357; Irvine, 2767; and Greenock, 876 tons. Coalmasters report that while the trade in main coals is hitherto good, they have been unable to obtain any advance in prices. Steam coals are in poor request in consequence of the dulness in the shipping trade. A fairly good trade is doing in Fife, where the shipping quotations are 6s. to 6s. 6d. a ton. Orders for domestic consumption are becoming more satisfactory in all the colliery districts.

The miners are pressing very hard for an increase of wages, and are adopting picketing and other means to enforce short time. Mr. William Small, secretary of the West of Scotland Miners, has addressed a letter to the masters in which he not only renews the demand for increased pay, but invites the employers to co-operate with the union in establishing an eight hours' day, and a five days' week, with the object of causing a dearth of coal, and leading to an increase in prices.

In consequence of the slackness in the shipbuilding and marine engineering trades at Greenock, a considerable number of workmen have been discharged. During September 13,331 tons of new shipping have been launched on the Clyde, against 37,012 in September, 1884. For the nine months the total output is 139,209, as compared with 226,877 tons in the corresponding period of last year.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

In addition to the coal firms which have secured a share of the Peninsular and Oriental contracts, I am glad to name the Plymouth Company, Harris's Navigation, and the National.

Buyers have every reason to be satisfied with their treatment at the hands of the Welsh coalowners. At several of the collieries I have visited lately not only is there great care exercised in seeing that the collier performs his part, and sends up as little shale as possible attached to the coal, but in the siding men are employed who rectify any slip, and trim the coal in the wagons previous to being despatched.

The despatch of coal is better over some of the lines, and slightly better at Cardiff and Newport, but there is ample room for more improvement both as to quantity and price. This will be seen from the exports. Last week Cardiff only sent away 108,789 tons; Newport, Mon., 30,598; and Swansea, 18,940 tons. In respect to Swansea this is the lowest we have recorded, and no wonder that a great deal of uneasiness prevails at that port, and I am afraid that both in connection with shipping and with collieries, trouble is looming ahead. Uncertain working of collieries, block of trucks, scarcity of orders, such are the leading features at this port, and Cardiff and Newport have not much to boast of. It is true that the Government and other contracts will soon show a difference, but what is wanted is a radical change in all branches affecting the smaller as well as the larger coalowners, and this cannot be expected until the general commercial depression of the country is removed or modified.

Another successful sinking by the Messrs. Cory is recorded. This and the success of the Messrs. Beith will add a large new field to the present coal riches of Wales, and what is more, one at least of the last successes suggests another, the new sinking on the estate of the Merthyr Board of Health, near Pontypridd. This takes the flat of the Taff Valley, and the only question is how far and to what extent the ancient sea, which coursed there, has affected the mineral deposits.

With the exception of a substantial cargo of rails to Halifax from Newport, I have not much to chronicle in respect of the iron and steel trade. The promising tone of things continues, though there is not much to show for it. One fact may be given, that more foreign ore is coming into port. Last week nearly 30,000 tons were received at Newport and Cardiff.

The patent fuel market shares somewhat the prevailing depression. Only a small consignment left Newport last week, and from Cardiff only 5025 tons, while from Swansea, which occasionally shows an export of close upon 10,000 tons, only 1518 tons were despatched. This, like the coal item, is one of the smallest known exports since the trade has been developed. Taking January totals to August, the monthly returns of exports amounted to an average of 23,000 tons. Cardiff, on the other hand, fluctuated from 13,000 tons a month to 27,000 tons.

There is a fairly good demand in the tin-plate trade, but I hear that one important firm, who had been outside of the combination, and then recently joined, has again placed himself without the "ring." Coupling this with the current statement that stocks have fallen very considerably, and yet that the make is about up to demand, prospects evidently do not look quite so bright as one would wish them to be.

It is yet early to prognosticate. I may, however, mention that in very sage circles it is a matter of sober discussion whether the combination must not fall through. Buyers continue to hang back. Another week or two will show which way the current will flow. I can only hope that prices may be sustained, combination or not, to give a fair margin of profit to those embarked in the trade. At the same time the "stop week" and "combination" can but be regarded as artificial aids; the only natural solution is that the weaker ones go to the wall, and then men of means will arrange a tolerably close quotation as will repay them, just as coalowners do. No combination or stop exists amongst coalowners, yet the variation in quotations is very small.

Gwerna Colliery, Maesycwmmer, is on strike, and the men have brought out their tools.

The Middleamman anthracite colliery and railway siding, Carmarthenshire, are being offered for sale.

Death of Mr. John Muirhead.—Mr. John Muirhead, whose name is known in connection with electrical and telegraphic advance, died on Thursday, the 24th ult., at his residence, Oakwood, Upper Norwood. He was one of the very few survivors of the early days of telegraphy, and no one was more closely connected with its practical development. Born in Haddingtonshire in 1807, he evinced a decided talent for constructive works. On the completion of the Britannia and Tubular bridges, Stephenson turned his attention to the problem of the electric telegraph, which at that time was struggling into existence. Mr. Edwin Clark was appointed chief engineer to the original Electric Telegraph Company, and Mr. Muirhead also joined the company, in which he remained until it was transferred to the Post-office in 1870. From his first connection with the company until within a few years of his death, Mr. Muirhead devoted himself continuously to the work of extending and perfecting the telegraph as we now know it. The early underground metropolitan lines were laid by him, and the pneumatic tube system for collecting messages from the various local stations to the central transmitting station in London and the large provincial towns was first installed under his supervision. Mr. Latimer Clark and the late Mr. Cromwell Varley did much to introduce and perfect this novel form of communication, which is now largely employed in all the great telegraphic centres. In the absence of manufacturing facilities such as exist now for supplying telegraphs to the world at large, Mr. Muirhead, in conjunction with Mr. Latimer Clark and Mr. W. M. Warden, of Birmingham, founded the house now known as Latimer Clark, Muirhead, and Co., more than a quarter of a century ago. This firm, in the course of its career, has planted the telegraph in every corner of the world, and, under the patents of Mr. Muirhead's sons, has doubled the carrying power of nearly all great submarine cables by what is known as the Muirhead duplex system. It was from this manufactory that Mr. Muirhead introduced the form of battery which bears his name, a form so eminently portable and practical that it has become the model for most of the existing batteries, while continuing itself to be largely employed. It is unnecessary here to enter into the subject of his various improvements and innovations; but sufficient has been said to show that the unremitting labours of men like Mr. Muirhead have, under great difficulties, brought the electric telegraph to its present perfection, and pioneered the way for the introduction of the 6d. tariff which is now in force, thus bringing the utility of this great invention within the reach of all.

NEW COMPANIES.

The following companies have just been registered:—

Brocklebank Railway Couplings Company, Limited.

This company was registered on the 17th ult. with a capital of £30,000, in £1 shares, to trade as founders, engineers, and smiths, but principally to carry into effect an agreement of the 10th inst., for the purchase from Mr. T. A. Brocklebank of letters patent relating to improvements in railway couplings. The numbers and dates of the patents to be taken over are as follows:—

No. 3876 .. 27th November, 1873.
No. 4409 .. 16th September, 1882.
No. 5205 .. 27th April, 1885.

The subscribers are:—

	Shares.
*Lord F. Fitzroy, 23, Grosvenor-street	1
H. Hince, 15, Walbrook, consulting engineer	1
G. Brocklebank, 15, Cornhill, stockbroker	1
E. Horton, Ama Works, Darlaston, manufacturer	1
*Alex. Brogden, M.P., 9, Victoria-chambers, Westminster	1
W. C. Croome, 9, Gracechurch-street, solicitor	1
H. H. Finch, 9, Gracechurch-street, solicitor	1
*T. A. Brocklebank, 24, Budge-row, inventor	1

The number of directors is not to be less than three nor more than five; qualification, 200 shares; remuneration, £500 per annum; the first are the subscribers denoted by an asterisk. Mr. T. A. Brocklebank is appointed managing director, and for the first five years will be entitled to a salary of £500 per annum and a commission of £10 per cent. on the amount available for dividend in each year. The purchase consideration is fully-paid shares of the aggregate nominal value of all the other issued shares, until the total share capital shall exceed £100,000, but in the event of any further issue the vendor will be entitled to one fully-paid share for every two shares thereafter allotted. The company will also pay £1500 in cash, to recoup the vendor for his past expenditure in patents, models, couplings, and outlay at the International Inventions Exhibition.

Beaver Cement Company, Limited.

Registered on the 18th ult. with a capital of £20,000, in £5 shares, to trade as cement manufacturers, cask manufacturers, and coopers. An unregistered agreement between Charles Jones and William Stark, of the one part, and the Company of the other part, will be adopted. The subscribers are:—

	Shares.
*C. Jones, 161, Tulse-hill, S.E.	1
*W. Stark, 6, Serle-street, Lincoln's-inn, solicitor	1
C. Bacon, Royal Oak-yard, Bermondsey, tanner	1
M. Jones, 161, Tulse-hill, widow	1
H. B. Cuming, Grove-lane, Camberwell, member of the Stock Exchange	1
F. Read, 9, West Cromwell-road, clerk	1
A. H. Bacon, London-road, Forest-hill, clerk	1

The number of directors is not to be less than two nor more than four; the first are the subscribers denoted by an asterisk.

Melksham Gaslight and Coke Company, Limited.

This company proposes to acquire the Melksham Gasworks, Wilts, and to supply gas for light, heat, and motive power. It was registered on the 21st August with a capital of £10,000, in £20 shares. The subscribers are:—

	Shares.
Wm. Bowley, Melton Mowbray, jeweller	64
C. H. Woodnn, Trowbridge, engineer	48
T. Hutton, Melksham, dealer	44
G. Perrott, Melksham	10
J. Hutton, Melksham, dealer	8
T. Hutton, Melksham, farmer	8
R. H. Sainsbury, Trowbridge, manager of gasworks	8

Registered without special articles.

Mesquital Del Oro Mining Company, Limited.

This company proposes to enter into an agreement with La Compania Restauradora Zacatecana del Mesquital del Oro for the acquisition of mineral and other property in the Republic of Mexico. It was registered on the 19th ult. with a capital of £100,000, in £5 shares, with the following as first subscribers:—

	Shares.
R. S. Archibold, 9, New Broad-street, merchant	1
*P. F. Gaskell, J.P., 1a, Queensbury-road, South Kensington	1
*E. Maddox Sweetland, Little Stanmore, merchant	1
J. G. Turney, 12, Thornton-hill, Wimbledon, merchant	1
J. C. Mason, Watford, Herts, merchant	1
J. M. Carey, 13, Fassot-square, Dalston, clerk	1
G. T. Verney, Dashwood House, New Broad-street	1

The number of directors is not to be less than four nor more than eight; qualification, 100 shares; the first are Messrs. James Whittall, T. K. Weir, and the subscribers denoted by an asterisk. The remuneration of the board will be £1000 per annum, and 5 per cent. on the total amount of the annual dividends, but £3000 per annum is to be the maximum.

Patent Radial Filter Press Company, Limited.

This company proposes to carry on the business of a Filter Press Company, and will carry into effect an unregistered agreement of the 17th ult. for the purchase of certain inventions, of which particulars are not given in the registered documents. It was incorporated on the 19th inst. with a capital of £6000, in £1 shares, with the following as first subscribers:—

	Shares.
*C. S. Hill, Oak Grange, Beckenham	1
*J. Bonthron, Pitlochry, Putney	1
*P. C. Don, 110, Cannon-street, merchant	1
*T. E. Foakes, 75, Chancery-lane, barrister	1
*E. B. Walker, Amberley, Surrey, landowner	1
D. K. Clark, C.E., 8, Buckingham-street	1
A. G. Spilsbury, St. John's, Lewisham	1

The subscribers denoted by an asterisk are the first directors; qualification, 50 shares; remuneration, 10 per cent. of the annual profits.

Effuenta Gold Mines Syndicate, Limited.

This company proposes to acquire the benefit of an agreement of the 18th of March, made by Edward Berman, as liquidator of the Effuenta Gold Mining Company, Limited, with regard to the working of the Effuenta gold mine, with option of purchase upon the terms therein expressed. The syndicate was registered on the 19th ult. with a capital of £2000, in £1 shares, with the following as first subscribers:—

	Shares.
Joseph Mason, 15, North John-street, Liverpool, shorthand-writer	1
Philip Le Rougetel, 27, Coltart-road, Liverpool, cashier	1
H. Lee, 9, Balmoral-road, Aintree, Liverpool, journalist	1
C. H. Lee, 176, Breck-road, Liverpool, reporter	1
J. Stagg, 28, Hamilton-street, Birkenhead, cashier	1
G. Hedley, Agricultural Society's Offices, Birkenhead	1
D. J. McKenzie, 29, Arundel-street, Liverpool, clerk	1

Registered without special articles.

CYLINDRICAL NUTS.

The substitution of cylindrical nuts for those of a square or a hexagonal form has been advocated, with very good reasons as a backing. Recently an opportunity was given to see a practical illustration. A machinist had an order for a small ornamental steam engine, to be placed in the show window of a coffee and spice establishment, and on it he used cylindrical nuts instead of hexagonal ones. The engine was a horizontal one, with steam chest on the top of the cylinder, and all the hold-down bolts were furnished with cylindrical nuts, through the tops of which protruded the flattened convex ends of the bolts, making a very neat finish. The bolts were ⅜in. diameter and the nuts ⅝in. diameter; to have made them hexagonal they would have been a trifle over ⅝in. from corner to corner, and if square they would have been a full inch across corners, and neither the hexagonal nor the square nut would be any stronger than the cylindrical nut—the protruding corners give no additional strength. For a wrench he took a tool with opening jaws operated like a pair of pliers. These jaws, while slightly open, were reamed to fit the diameter of the nut, so that when closed on the nut the jaws would embrace almost its entire circumference; the leverage of the handles made a very slight pressure necessary to set up the nuts. The wrench did not have a short biting jaw, like a pair of pipe tongs, which dig into the pipe at each grip, but the inside of the jaws were perfectly smooth, and left no mark on the nut in using.

The method of making the nuts produced them in a very rapid manner. A bar of steel, of the proper diameter to finish to size after being turned, was fed through the head of a turret lathe, the end squared, a hole drilled in it, the tap run in, the surface turned, and the nut cut off; all done by fixed tools in the turret and the cross cutting off tool. The finished nut dropped, and the bar was advanced for another nut. There was no planing, milling, or seating on an arbour, as would be the case in forming and finishing rectangular nuts. Every machinist knows that lathe work is cheaper and quicker than reciprocating work, whether planer or milling machine.

In addition to these advantages of quick work, almost self-acting, the rapid production of the nuts and their finish from the first inception, there is the advantage of the requirement of less metal for the requisite strength. The embracing jaws of the wrench have a bearing on almost the entire circumference, while on the square and hexagon nuts the bearing of the wrench is on only two opposite sides.

Another advantage that the cylindrical nut has over the angular nut is that the wrench may get a grip in moving through the smallest arc of a circle—an advantage that will be appreciated by the setters-up of machinery under difficulties. With the square nut an entire quarter turn is required before, in a confined space, the wrench can get a new hold; and with the hexagonal nut not less than one-sixth of a revolution is necessary before the wrench can take a fresh grip. When the wrench handle is long and the working place is limited, these considerations are of consequence.—*Scientific American.*

Production of Gold and Silver in the United States.—The Mint authorities estimate the production in 1884 at 30,800,000 dols. gold and 48,800,000 dols. silver, coining rate; total, 79,600,000 dols. This was an increase of 800,000 dols. gold and 2,600,000 dols. silver, as compared with 1883.

Colne Valley Waterworks.—The Colne Valley Water Company has lately completed at its place near Watford, some works for the augmentation of its water supply, which consist of an additional well connected by an underground adit with their pumping well, and also a boring which has been carried to a depth of 700ft. from the surface of the ground, and which yields about 650,000 gallons per twenty-four hours. This boring is 18in. diameter, and has been carried right through the chalk down to the gault underneath, which was pierced a few feet only for the purpose of identifying it, and although previously to the execution of this boring it had been assumed by those having the largest local experience that no supply of water would be found in the lower chalk at more than about 200ft. from the surface, yet the result proved that the greater portion of the water, viz., 400,000 gallons, was yielded by the beds between 200ft. and 500ft. deep, and very much of it about the latter depth. The boring was executed with much rapidity, having been only twelve weeks in hand, giving an average of 55ft. per week, including Sunday stoppages. These works have been carried out by Messrs. W. Hill and Co., of 26, Great George-street, Westminster, under the supervision of Mr. W. Fox, C.E., acting on behalf of Mr. J. F. Latrobe Bateman, C.E. The Colne Valley Water Company, having acquired parliamentary powers to take over the undertaking of the Harrow Waterworks, is making extensive preparations by putting down additional engines, boilers, and pumping machinery, and also laying new mains to meet the increased demands which will thus be made upon its resources.

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.

22nd September, 1885.

11,224. Electric Baths, M. Humm, London.
11,225. Gate Latches, E. Jones, Lee.
11,226. Reed Hooks for Weaving Looms, J. Aspden, Halifax.
11,227. Attaching Handles to Tea Pots, C. J. Gilbert, Sutton Coldfield.
11,228. Staircases, &c., J. Totton, Manchester.
11,229. Painting, &c., Figures in Relief, P. Smith, Manchester.
11,230. Excluding Draughts from Doors, S. Farrar, Halifax.
11,231. Stopping and Starting Tram-cars, &c., W. Arbuckle, Manchester.
11,232. Mechanical Nurse Chairs, L. L'Hollier and J. J. Rochford, Birmingham.
11,233. Suspending Pictures, W. H. Smith, Birmingham.
11,234. Wheelbarrows, K. Proctor, London.
11,235. Rotary Engines or Motors, C. T. Colebrook, London.
11,236. Drawing Boards, J. Sims, London.
11,237. Padding Figured Goods, R. Hodgkinson and A. R. Arnold, Manchester.
11,238. Automatic Cutter for Looms, I. Whittaker, Leeds.
11,239. Clay Bats, A. Cochran, Glasgow.
11,240. Folding Chairs, A. Plant, Glasgow.
11,241. Needle Threader, J. Darling, J. M. Parker, W. McGowan, and R. C. Lyness, Glasgow.
11,242. Churns, T. Bradford, Manchester.
11,243. Plates for Secondary Batteries, J. Henry, Louth.
11,244. Facing Nut Seats on Pipe Flanges, T. White, Glasgow.
11,245. Steam Cargo Whips or Winches, D. D. Napier, Glasgow.
11,246. Stop Motion for Spinning Machinery, B. A. Dobson, Manchester.
11,247. Spinning and Doubling Spindles, B. A. Dobson, E. Gillow, and R. Crabtree, Manchester.
11,248. Steam Boilers, J. C. Jopling, Sunderland.
11,249. Lawn Tennis Poles, R. B. Lee, Manchester.
11,250. Cylindrical Furnaces, J. M. Gray and D. Purves, London.
11,251. Shrinking, &c., Trousers Bottoms, J. Wood, Halifax.
11,252. Glass Bottle Fire-extinguishers, L. Dill, London.
11,253. Interlink Wire Net, J. R. Collier and D. S. Musgrave, London.
11,254. Straight Mesh Wire Work, J. R. Collier and D. S. Musgrave, London.
11,255. Destroying Bad Smells in Sewers, G. R. Keeling, Epsom.
11,256. Driving Velocipedes, A. S. Bowley, London.
11,257. Automatic Cut-offs for Gas Burners, A. M. Clark.—(*J. E. Birch and D. Henderson, Canada.*)
11,258. Alcohol, Hydro-carbons, and Acetic Acids, D. D. Cattanach, London.
11,259. Heads for Circular Ribbed Fabric, J. H. Cooper and W. J. Ford, London.
11,260. Wheels for Bicycles, G. E. Brown, London.
11,261. Musical Boxes, P. Lochmann, Liverpool.
11,262. Barbed Wire Making Machine, C. Mackay, H. Walden, H. North, and R. Wyper, Liverpool.
11,263. India-rubber Balls, J. Y. Johnson.—(*J. P. Rider, U.S.*)
11,264. Telephone, G. L. Anders, London.
11,265. Transmission, &c., of Telephonic Sounds, H. A. Kent, London.
11,266. Water Break, J. H. Konter and J. Chaffaud, France.
11,267. Enabling Persons to Hold the Pen, J. Barter, London.
11,268. Producing Light and Heat, W. Barraclough, London.
11,269. Embroidering, H. J. Haddan.—(*V. Keller and B. Rössiger, Germany.*)
11,270. Cement, E. W. Killick, London.
11,271. Kilns, E. W. Killick, London.
11,272. Pipe Moulds, C. Price, London.
11,273. Screen Attachment, A. M. Clark.—(*F. Seeley, U.S.*)
11,274. Printing Machines, B. Thompson, London.
11,275. Mortice Locks, F. J. Biggs, London.
11,276. Rotary Engines, W. R. Lake.—(*C. H. Cary, U.S.*)
11,277. Motive Power, R. Harrison and W. Oliver, London.
11,278. Waistcoats, A. Halford, London.
11,279. Railway Wheels, C. C. Braithwaite, London.
11,280. Coating Metal Plates with Tin, &c., D. Davis, London.
11,281. Locking Nuts, C. Henderson, Glasgow.
11,282. Bricks, &c., J. Howie, Glasgow.
11,283. Emery Wheels, J. J. and J. R. Flitch, London.
11,284. Staking and Grounding Leather, J. J. and J. R. Flitch, London.
11,285. Fire and Sound Proof Flooring, J. W. Ludlam and S. S. Harvey, London.
11,286. Driving Belts, F. J. B. Duff, London.
11,287. Keeping Cigars and Pipes Alight, J. W. Oddie, London.
11,288. Apparatus for Playing a Game Called Olo, F. H. Stirling, London.
11,289. Boot and Shoe Stretchers, P. Calder and E. Shayler, London.
11,290. Gas Engines, &c., G. F. Redfern.—(*G. Smyers, Belgium.*)
11,291. Self-acting Chocks for Supporting Ships' Boats, L. P. Nielsen, London.
11,292. Construction of Metal Bedsteads, E. Peyton, London.
11,293. Revolving Cultivators, J. T. B Campbell, London.
11,294. Gas Engines, A. M. Clark.—(*The Economic Motor Company, United States.*)
11,295. Steam Engines, J. Wheelock, London.
11,296. Cleaning Wool, &c., J. C. Fell.—(*B. Merrien and P. Levandier, France.*)

23rd September, 1885.

11,297. Warp Lace Machines, A. Dawson and E. Smith, London.
11,298. Gearing Velocipedes, G. E. Morgan, London.
11,299. Admission Valve for Gas Engines, T. Sturgeon, London.
11,300. Dynamo-electric Generators, T. J. Handford.—(*R. H. Mather, United States.*)
11,301. Application for Stopping Tramcars, W. Hartley, Bradford.
11,302. Miners' Safety Lamps, J. Olner, Birmingham.
11,303. Holders for Umbrellas, &c., S. Wilson, Manchester.
11,304. Shuttle Tongues, &c., I. and A. Wallwork, Manchester.
11,305. Checking the Number of Persons in Places of Amusement, W. A. M. Brown and J. M. Porter, Leeds.
11,306. Hat Guards, F. W. Cheetham and W. Davenport, Manchester.
11,307. Secondary Voltaic Batteries, C. Moseley and T. Parker, Manchester.
11,308. Displaying Advertisements on Cruets, A. W. H. Wood and A. Sinclair, Ullesthorpe.
11,309. Dredging, &c., Wells, &c., C. C. Sullivan, London.
11,310. Fancy Weaving, J. H. Pickles, Manchester.
11,311. Case-hardening Metals, J. Robb, Dundee.
11,312. Washing and Drying, H. Smith and J. E. S. Perkins, Peterborough.
11,313. Presses for Hay, &c., H. C. Capel, London.
11,314. Velocipedes, H. Smedley and W. J. Green, Nottingham.
11,315. Portable Furniture, S. Johnson, Manor Park.
11,316. Distributing, &c., the Supply of Gaseous Fluids, A. Budenburg.—(*E. Schmeiding, Germany.*)
11,317. Photographic Apparatus, H. Lucas, Birmingham.
11,318. Excavators, Grabs, &c., S. M. Cockburn, London.
11,319. Shuttle Guards for Looms, R. Smyth, Tullyelmer.
11,320. Gas-burners, Lamps, &c., S. Lilley, Birmingham.
11,321. Locking Railway Carriage Doors, F. W. Webb, Birmingham.
11,322. Pipes for Smoking Tobacco, &c., C. W. Todd, Birmingham.
11,323. Jackets for Light and Heavy Guns, T. H. Heard, Sheffield.
11,324. Grinding, &c., Substances, A. W. Gleed, Sheffield.
11,325. Cover for School, &c., Slates, H. G. Boorn-Thompson, London.
11,326. Street Tramway Points, T. M. Lynch, Liverpool.
11,327. Gas and Lamp Globes, A. Cochran, Glasgow.
11,328. Shuttles, E. Rowley, London.
11,329. Pumping Water, P. Teague and W. H. Thomas, London.
11,330. Trousers and Drawers, J. C. W. Masterman, London.
11,331. Arranging the Inducing Circuits of Secondary Generators, L. Gaulard and J. D. Gibbs, London.
11,332. Open Metal Work, J. Y. Johnson.—(*F. Tentschert, Austria.*)
11,333. Heating and Lighting Appliances for Domestic Purposes, S. S. Sugden, Woodford.
11,334. Window Fastener, E. Sloan, London.
11,335. Actuating the Pickers in Looms, J. and E. Horrocks, London.
11,336. Indicating the Velocity of Machinery, &c., H. W. Schlotfeldt, London.
11,337. Making Screws for Scarf-pins, &c., W. J. McMullen, London.
11,338. Self-recording Ship's Logs, P. Büsche.—(*R. Rieth, Germany.*)
11,339. Actuating the Shutters of Photographic Cameras, F. Shew, London.
11,340. Dynamo-electric Machines, The Varley Electric Patents Proprietory, and F. H. Varley, London.
11,341. Turnip Topping, &c., Machines, R. Brigham, Glasgow.
11,342. Cigarette Paper, E. C. F. Otto and J. F. Peasgood, London.
11,343. Storage Batteries, J. Fraser, London.
11,344. Velocipedes, R. E. Phillips, South Norwood.
11,345. Metal Lasts, W. Ebbern, London.
11,346. Short Lace Curtains, &c., E. M. Wrighton, London.
11,347. Hair Pins, G. A. Spratt, London.
11,348. Speaking Tubes, W. R. Lake.—(*J. A. Kessel and M. Glwick, United States.*)
11,349. Clamp, E. Edwards.—(*A. M. Ognard, France.*)
11,350. Canisters, J. Cunningham, W. Creswick, and J. W. Dixon, Sheffield.
11,351. Ornamenting Glass, China, &c., J. Slater, London.
11,352. Mounting Ordnance, J. Vavasseur, London.
11,353. Candle Lamps and Chandeliers, S. Clarke, London.
11,354. Cocks and Taps, C. Jackson, London.
11,355. Siphons, P. B. Eygretean, London.
11,356. Tipping Wagons or Trucks, H. Grafton, London.
11,357. Converters, A. M. Clarke.—(*H. Harmet, France.*)
11,358. Consuming Oils for Generating Steam, &c., R. and H. B. F. Barker, London.
11,359. Heating Furnaces, R. Barker, London.
11,360. Vases, G. Jackson, London.

24th September, 1885.

11,361. Treating Iron and Ores, &c., T. Williamson, Wishaw.
11,362. Adjustable Shaft Bearing or Journal Box, H. P. Trueman, Hockley.
11,363. Mules for Spinning, A. Dearnley, Huddersfield.
11,364. Mineral Water Cases, H. T. Chappell, Bath.
11,365. Joining the Ends of Metal Rods or Tubes, W. Green, Manchester.
11,366. Joints of Railway Rails, &c., N. V. P. Poirin, London.
11,367. Cupolas for Smelting Metals, &c., T. Williamson, Wishaw.
11,368. Subjecting Fabrics to the Action of Steam, D. Stewart, Glasgow.
11,369. Paper Pin, J. Meadowcroft, Runcorn.
11,370. Copying Written Documents, W. Beatson, Rotherham.
11,371. Making Rough Metal Plates, J. Bryce, Glasgow.
11,372. Self-closing Connection for Valves, &c., C. H. Ancill, Birmingham.
11,373. Braces, F. W. Lambert, Birmingham.
11,374. Formation of Bottles, A. W. Preston, Kirkburton.
11,375. Winning Coal, A. McDougall, Penrith and C. W. Wilson, Kirby-Lonsdale.
11,376. Supports for Standard Rose Trees, W. A. Cartwright, Manchester.
11,377. Elevating Liquids by means of Steam, E. Körting, London.
11,378. Valves, J. W. Clarke, Liverpool.
11,379. Bung-joints, L. Mayer, London.
11,380. Construction of Weirs, R. H. Twigg, London.
11,381. Electric Lamps, A. Brin, London.
11,382. Water Heating Apparatus, J. Osgerby, London.
11,383. Opening and Closing Fire-mains, G. L. Pearson and A. Norman, London.
11,384. Reversing the Slide or other Steam Distributing Valves of Steam Engines, H. S. Lancaster, Liverpool.
11,385. Hammock Supports, C. A. Lindblom and J. Mitchell, London.
11,386. Photographic Cameras, H. Park, London.
11,387. Cooking Ranges, J. B. Colbran, London.
11,388. Blending Tea, R. H. Broom, London.
11,389. Stoves or Warming Apparatus, C. L. Heydemann.—(*R. Heydemann, Prussia.*)
11,390. Christmas-tree Stands, B. Hawerkamp.—(*Roessmann and Kuehnemann, Berlin.*)
11,391. Kettles for Boiling Asparagus, &c., B. Hawerkamp.—(*B. Ebeling, Bremen.*)
11,392. Combing Machinery, G. Wilkinson, London.
11,393. Printing Machines, A. M. Clark.—(*A. H. Marinoni and J. Michaud, France.*)
11,394. Trusses, B. F. Atkinson, London.
11,395. Manufacturing Plate Glass, A. D. Brogan, Glasgow.
11,396. Supplying Water to Water-closets, J. R. Davies, London.
11,397. Indicator for Water-closets, &c., J. Beresford and W. Restall, London.
11,398. Rings or Clips for Suspending Curtains, &c., W. West, London.
11,399. Clipping Horses, Shearing Sheep, &c., J. Trickett, London.
11,400. Stretching Trousers, Cloth, &c., L. Sterne, London.
11,401. Revolution Indicators or Counters, E. E. Wigzell, London.

25th September, 1885.

11,402. Decarbonising, &c., Fluid Iron Metal, B. H. Thwaite, Tranmere.
11,403. Water-waste Preventer, J. Howlett, Kingston-upon-Hull.
11,404. Clasps for Stay Busks, B. G. Simpson, London.
11,405. Automatic Leveller, E. Richards, Stoke-on-Trent.

11,406. Heating Buildings, J. F. Smith and G. Duxbury, Leicester.
11,407. Operating Railway, &c., Signals, H. Johnson, Manchester.
11,408. Paring Heads and Cutters, H. B. Milsom, Bristol.
11,409. Carbon Plates for Secondary Batteries, W. Symons, Barnstaple.
11,410. Fastening Swing Mirrors, W. H. Harvey, London.
11,411. Boiler, J. Sephton, Birkdale.
11,412. Jacquard Card Punching Machines, H. B. Payne, Nottingham.
11,413. Cartridge Pouches, N. W. Wallace, Southsea.
11,414. Pumps, J. J. Pearson and T. H. Taylor, Newcastle-on-Tyne.
11,415. Automatic Sighting of Heavy Guns, J. G. Grant, Dundee.
11,416. Motive-power Apparatus, J. Murrie, Glasgow.
11,417. Screw-lid Tin Box, G. Lindsey, Monmouth.
11,418. Address Labels, A. H. Broadbent, Liverpool.
11,419. Cutting off Impure Air from Urinals, &c., T. Breckell, Liverpool.
11,420. Preventing "Trailings in" in Looms, R. Field and T. Gelder, Halifax.
11,421. Filaments for Electrical Glow Lamps, J. Swinburne, Brockley.
11,422. Gas Engines, J. Magee, Glasgow.
11,423. Combined Cartridge Packing and Loading Box, W. P. Jones, Birmingham.
11,424. Clearer Winding Frames, T. Guest and T. Brookes, Manchester.
11,425. Hygienic Window Blind Suspender, T. Hill and W. H. Wells, Hull.
11,426. Drawing off Corn from Silos, G. Henderson, Liverpool.
11,427. Purifying Iron, &c., W. P. Thompson.—(*L. Imperatori, Germany.*)
11,428. Removing Varnish from Oil Paintings, E. Compton, Worthing.
11,429. Stiffening Finish for Crapes, &c., J. Kenyon, London.
11,430. Strengthening Rolled Metal Girders, C. Auty, Sheffield.
11,431. Printing with Metallic Substances, &c., A. Shaw, Hanley.
11,432. Cartridges for Blasting, R. Punchon and the Patent Oxonite Company, London.
11,433. Regulating Clocks, H. Aron, Glasgow.
11,434. Toothed Gearing, M. P. Campbell and J. MacCullum, Glasgow.
11,435. Bicycles, J. Devey, London.
11,436. Treating Sewage, C. T. Kingzett, London.
11,437. Rapidly Heating Flowing Water, C. E. Hearson, London.
11,438. Signal Buoys for Sea Coasts, E. E. Mann, London.
11,439. Traction Engines, H. J. Haddan.—(*L. C. Taber, United States.*)
11,440. Stuffing-boxes for Steam Engines, H. J. Haddan.—(*S. Berry, United States.*)
11,441. Screws, G. G. Glanville, London.
11,442. Watchman Detector and Alarm Apparatus, W. Doehring, London.
11,443. Wheels, W. and W. D. Bohm, London.
11,444. Looms, J. M. Collins, Glasgow.
11,445. Gas Lamp or Stove, A. H. Hearington, N. L. Ghosh, and A. Darlow, London.
11,446. Photographic Sheets, O. L. Hulbert, London.
11,447. Casks, W. W. Druce, London.
11,448. Steering Apparatus for Bicycles, &c., A. Wheeler, London.
11,449. Removing, &c., the Fumes of Nitro glycerine in Blasting, J. Darlington.—(*J. C. Newbery, Australia.*)
11,450. Splitting Rattan, F. W. Grauert, London.
11,451. Boxes or Trunks, F. W. Grauert.—(*D. N. Bancroft, United States.*)
11,452. Shaving Rattan, F. W. Grauert, London.
11,453. Inhaler, H. L. Leigh, London.
11,454. Voltaic Batteries, T. J. Jones, London.

26th September, 1885.

11,455. Embroidering Machine, W. Humphreys and I. Wyer, London.
11,456. Fastenings for Studs, &c., L. P. Conard, London.
11,457. Semaphore Signalling Apparatus, T. D. Weir, Glasgow.
11,458. Manufacture of Bricks, J. Farmer, Manchester.
11,459. Flexible Jointed Tooth Brush, C. G. Ash, Chester.
11,460. Detaching Link, H. P. Trueman and J. G. New, Birmingham.
11,461. Gas Burners, M. Smith, Birmingham.
11,462. Manufacture of Bricks, &c., C. Walton, London.
11,463. Feed Apparatus for Disintegrators, R. Smith, London.
11,464. Facilitating Instruction in Geography, M. C. Sturgeon, London.
11,465. Regulating the Speed of Motive-power Engines, S. Butterworth, Manchester.
11,466. Knitting Machines, J. Higham, Manchester.
11,467. Hot Air Furnaces, J. Pickering, Walton.
11,468. Double Weft Motion for Looms, J. Belicard, Manchester.
11,469. Valves of Fluid Pressure Engines, R. Richardson, Glasgow.
11,470. Measuring Horses' Necks for Fitting Collars, R. J. P. Spence and R. Storrar, jun., Letham.
11,471. Securing Fenders to Mantelpieces, F. Druce, Sheffield.
11,472. China Nobs, G. S. Marshall and W. Allman, Birmingham.
11,473. Water Filters, R. R. Kelly, London, and A. C. L. Weigel, Hove.
11,474. Lip Respirator, G. W. Clements, London.
11,475. Joints for Metal Plates, H. Turner, Liverpool.
11,476. Mattresses, F. Caspary, London.
11,477. Carriage Roofs, W. Heatley and G. Hutchins, London.
11,478. Type Writing Apparatus, M. A. Wier, London.
11,479. Fastening Bags, &c., G. Thomas, London.
11,480. Holders for Curtain Rods, G. S. Marshall and W. Allman, Birmingham.
11,481. Back Plates of Cabinets, &c., G. S. Marshall and W. Allman, Birmingham.
11,482. Motive-power Apparatus, J. Murrie and J. Thompson, Glasgow.
11,483. Soles of Boots, R. S. Moss, London.
11,484. Machines for Embossing, &c., A. J. Boult.—(*M. A. and G. R. Heath, United States.*)
11,485. Filtering Apparatus, A. J. Boult.—(*E. M. y Miura and C. Pinal.*)
11,486. Main Springs of Watches, &c., A. Schierwater, Liverpool.
11,487. Feed for Automatic Scales, C. F. Wood, Middlesex.
11,488. Fastening Wheels or Pulleys upon Axles or Shafts, H. J. Macklin, London.
11,489. Tea, J. D. Treharne, London.
11,490. Brushes, C. P. Merriam and J. Robins, London.
11,491. Treating Sewage, &c., J. S. Randles, London.
11,492. Distributing or Conveying Liquors to Cisterns or Tanks, J. Brock and E. Saye, London.
11,493. Hansom Cabs, C. A. Floyd, London.
11,494. Metal Wire and Rods, J. G. Parker, London.
11,495. Aerated Beverages, G. H. U. Harrow and C. G. Matthews, London.
11,496. Sieve or Strainer, J. Pearson, Ashton-on-Ribble.
11,497. Fire-escape, J. Young, London.
11,498. Converting Reciprocative into Rotary Motion, &c., J. Glover, London.
11,499. Soldering Aluminium, J. S. Sellon, London.
11,500. Telephonic Instruments, S. P. Thompson, London.
11,501. Telephones, S. P. Thompson, London.
11,502. Weighing Machines, H. L. Stannard, London.
11,503. Enlarging Holes in Metal Plates, R. A. Baillie and L. Chapman, London.
11,504. Friction Clutches, J. B. Hall, London.
11,505. Raising and Lowering Sliding Sashes, J. H. Fox, London.
11,506. Elevating and Discharging Grain, &c., T. Schofield, London.

28th September, 1885.

11,507. Water-heating Apparatus, J. S. and S. H. Stubbs, Manchester.
11,508. Bedsteads, J. King, London.
11,509. Vices, T. Crossley and J. McGregor, Manchester.
11,510. Mechanical Telephones, &c., R. H. Ridout, London.
11,511. Earth Clips for Forming Electrical Circuits, A. Whalley, Halifax.
11,512. Driving Gear of Washing Machines, T. T. Mercer and T. Woolfall, Halifax.
11,513. Connecting Electric Wires, A. Whalley, Halifax.
11,514. Accurate Adjustment of Card Flats, E. Tweedale, Halifax.
11,515. Brakes for Weaving Looms, J., J., and J. Ward and W. M. Leeming, Halifax.
11,516. Locking and Unlocking Railway Carriage Doors, E. Baldwin, London.
11,517. Giving Motion to Projectiles, E. H. Story, Liverpool.
11,518. Boots for Football, W. H. Stevens, Leicester.
11,519. Gas Regulators, T. Thorpe, Whitefield.
11,520. Making Compound Fuel, R. Walker, Sunderland.
11,521. Brackets for Roller Blinds, G. S. Marshall and W. Allman, Birmingham.
11,522. Lamps, W. Soutter and Sons, Birmingham.
11,523. Queen Mab Embroidery Frame, M. A. Turner, London.
11,524. Brake, A. M. Edwards, Bristol.
11,525. Metallic Poles for Telegraph Lines, W. Skinner.—(*F. N. Gisborne, Canada.*)
11,526. Labels, D. Dalziel, Glasgow.
11,527. Mats, J. and J. Lee, Halifax.
11,528. Material for Stereotype Matrices, &c., P. M. Justice.—(*W. H. Knowles, France.*)
11,529. Waterproof and Anti-corrosive Composition, E. L. Kitchingman and A. Andrews, London.
11,530. Releasing Spring Bolt of Locks, W. A. Gill, London.
11,531. Hydrocarbon Lamps, E. Ehrich and A. Graetz, London.
11,532. Protecting Rings from Wasting by Friction while being Worn on the Hand, H. Carruthers, Tynemouth.
11,533. Friction Brakes, C. Jackson, Nottingham.
11,534. Fastening for Casements, &c., F. Cox, London.
11,535. Mercurial Vacuum Pumps, R. Dick and R. Kennedy, Glasgow.
11,536. Mounting of Saddles for Bicycles, J. A. Lamplugh, G. F. Brown, and A. T. Mason, London.
11,537. Washing Machines, W. T. Venable, London.
11,538. Treating Cast Iron for Making Iron and Steel, A. M. Clark.—(*C. Cholat and F. Mercier, France.*)
11,539. Revolving Back Collars, &c., E. Partridge, London.
11,540. Fastening of Railings in the Ground A. J. Boult.—(*Messieurs Lebas and Company, France.*)
11,541. Stoppering Bottles, Jars, &c., L. Dove, London.
11,542. Making Vitriolised Ash, T. H. Cobley, Dunstable.
11,543. Anti-fouling Composition, J. W. Carr and J. Dickinson, London.
11,544. Steering Gear for Cycles, S. C. Maguire, London.
11,545. Altering Throw of Crank for Cycles, S. C. Maguire, London.
11,546. Tow-hooks, &c., M. W. Aisbitt, London.

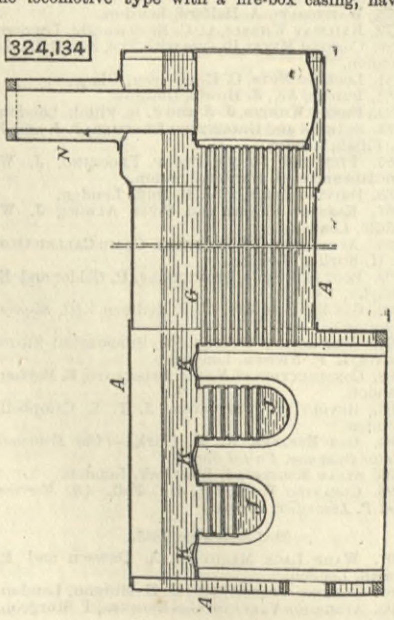
SELECTED AMERICAN PATENTS.

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

324,134. Steam Boiler, *William Malam, Edge Moor, Del.—Filed April* 15*th*, 1885.

Claim.—(1) The combination of the casing and tubed cylindrical barrel of a boiler of the locomotive type with a fire-box casing having tubed transverse water-legs in the upper portion of the combustion chamber, as set forth. (2) The combination of the casing and tubed cylindrical barrel of a boiler of the locomotive type with the fire-box casing, having tubed transverse water-legs J and crown plates K, as set forth. (3) The combination of the casing and tubed barrel of a boiler of the locomotive type with a fire-box casing, having

324,134



tubed transverse water legs in the upper portion of the combustion chamber, the forward leg being deeper than the rear leg, as set forth. (4) The combination of the fire-box casing, having tubed transverse water-legs, the tubes G, the smoke-box and stack, and the boiler casing extended to enclose the smoke-box and lower portion of the stack, and having a drum N, enclosing the upper part of the stack, as set forth. (5) The combination of the tube sheet, the smoke stack, and the smoke-box having a corrugated casing, with the casing A of the boiler, having an expanded front sheet enclosing the smoke-box, as set forth.

324,104. Wrench, *William D. Goodson, Eufaula, Ala.—Filed March* 30*th*, 1885.

Claim.—(1) In a lever wrench, the combination, with a bar having a key formed on its end, of an additional bar, held on the first-mentioned bar, and also provided with a key on its end, substantially as herein shown and described. (2) In a lever wrench, the combination, with a straight bar having a key formed on its end, of a bar having a curve, and held on the straight bar, which curved bar has a key formed on its end, substantially as herein shown and described. (3) In a lever wrench, the combination, with the straight bar B, provided with the longitudinal slot C, on the end of which bar the key D is formed, of the bar E, provided with a curve *e*, and the key F at the end, and of the bolt F^1, passed through the bar E and the slot C of the bar B, substantially as herein shown and described. (4) In a lever wrench, the combination, with the bar B, having

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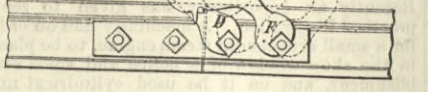

the slot C and forming the key D, of the bar E, forming the key F, and provided with a prong or lug G and recess *f*, the stud or pin *a* on the bar B, and the bolt F^1, substantially as herein shown and described.

324,362. Lubricator for Steam Engines, *John W. Cloud and Samuel Porcher.—Filed July* 9*th*, 1885.

Claim.—(1) A sight-feed lubricator for steam engines provided with means for attachment at its base only, a main condenser, and an auxiliary condenser above and communicating with the sight-feed glass, in combination with a single passage extending from said base upward, both for supplying steam to the condensers and for conducting the lubricant downward, substantially as and for the purpose set forth. (2) The combination of the oil reservoir, the main condenser, the sight-feed glass and its connections, the auxiliary condenser above the outlet of the sight-feed glass, and the passage *a*, extending from the base of the lubricator up into the main condenser and communicating directly with both condensers, substantially as and for the purposes hereinbefore set forth. (3) The combination of the globe valve provided with independent and separate passages, one for oil and steam and one for steam only, the lubricator provided with the passage *a*, communicating only with the oil passage of the globe valve, and a pipe communicating with the steam passage of the globe valve and extending up through the passage *a*, substantially as and for the purposes hereinbefore set forth. (4) A sight-feed lubricator for steam engines, provided with means for attachment at its base only, and having an upwardly-

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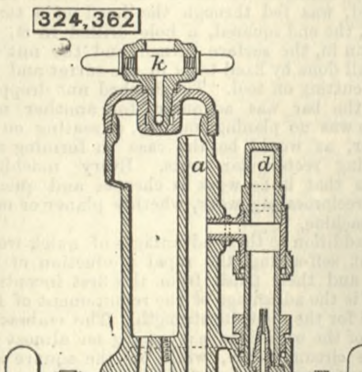
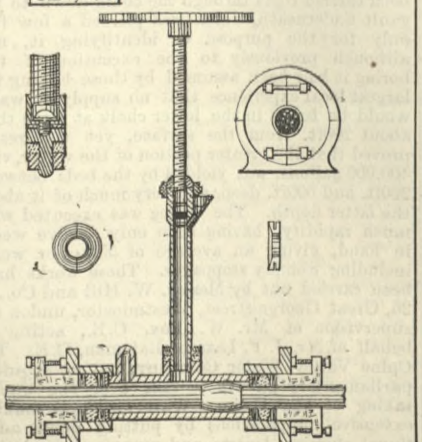


extending passage *a*, in combination with the screw-cup *k*, applied to the top of the condenser, and constructed and arranged, substantially as described, so that it may be used at will as a seal to the condensing chamber or as a means by which lubricant can be supplied through the condenser and passage *a* in case the sight feed should become disabled, substantially as hereinbefore set forth. (5) In a sight-feed lubricator, the combination, with the oil cup, the main condenser, and the sight-feed chamber, of an auxiliary condenser *d*, arranged above the outlet passage of said chamber so as to be wholly available as a condenser, and adapted to continuously supply the sight-feed chamber with clear water, substantially as hereinbefore set forth.

324,412. Hydrostatic Testing Machine for Telegraphic Cables, *William R. Patterson, Chicago, Ill.—Filed March* 22*nd*, 1884.

Claim.—In a hydrostatic press, the combination, with the barrel, of the screw-threaded piston rod, the nut and the piston connected to said rod by a swivel

324,412



joint, whereby the piston may be forced down without being turned by the piston rod, substantially as shown and described.

324,372. Duplex Pumping Engine, *Harvey S. Gaskill, Lockport, N.Y.—Filed June* 4*th*, 1885.

Claim.—(1) In a duplex pumping engine, the method of controlling the admission of steam to the cylinders by causing each piston, through the medium of a single valve rod having longitudinal and rotary reciprocating motions, to cut off the admission of steam to its own cylinder and move the steam valve so as to admit steam to one end and exhaust it from the opposite end of the other cylinder, substantially as herein specified. (2) The method of admitting steam

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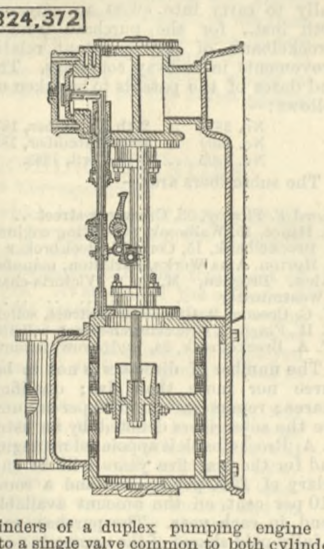
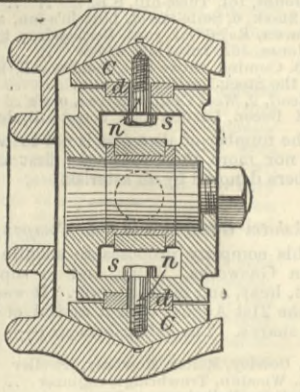


to the cylinders of a duplex pumping engine by imparting to a single valve common to both cylinders four rectangular movements, two movements in a direction parallel with the axes of the pump cylinders and two movements in a line approximately at right angles with the axes of the cylinder, as herein specified.

324,367. Engine Crosshead, *William J. Creelman, Rochester, N.Y.—Filed April, 2nd*, 1885.

Claim.—(1) The combination, with the body of an engine crosshead, of the adjustable gibs C, wedge-shaped in cross section, bearing upon slides having V-shaped grooves, the adjustable wedges or keys *d*, between the body of the crosshead and the said gibs, and the clamping-screws *n*, substantially as and for the purpose set forth. (2) The combination, with the body of an engine crosshead and the adjustable gibs C working in grooved slides, of the wedges or key *d* between the body of the crosshead and the said gibs, the adjusting screws *k*, by means of which the said wedges or keys are moved in the direction of their

324,367



taper, and the clamping screws *n*, substantially as set forth. (3) The body of an engine crosshead having grooves formed in its opposite sides, and the gibs C, having grooves formed in their sides, in combination with slotted tapering keys or wedges *d*, fitting in said grooves, and moved in the direction of their taper by means of adjusting screws *k* and the clamping screws *n*, which are passed through the respective walls *s* of the crosshead and the slots in the keys and threaded in the gibs, substantially as set forth.

324,438. Bilge Pump, *Michael Waters, Buffalo, N.Y.—Filed July* 6*th*, 1885.

Claim.—(1) The combination, with the bed-piece and pump cylinders, of the connecting duct C, standards D, secured to and upon said connecting piece C, connecting brackets T, and the mechanism consisting of worm G^1, worm wheel S, shaft G, spur wheel R, pinion Q, shaft E, with cranks P, and connecting-rods N, with pistons K, the whole being connected and

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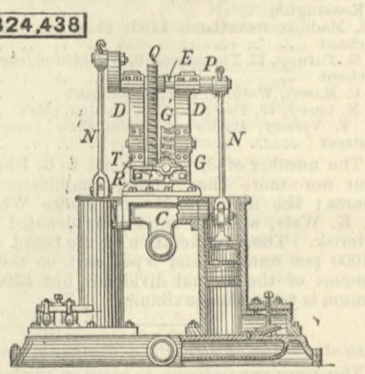

combined substantially as and for the object specified. (2) In bilge and other pumps, the combination, with the pump cylinders, of two standards secured to or formed in one piece with the connecting discharge duct, a worm wheel mechanism, and the spur wheel and pinion connection for giving motion to the crank shaft, substantially in the manner as and for the object specified.

324,444. Lock Hinge, *Josef Wolf, Hoboken, N.J.—Filed December* 10*th*, 1884.

Claim.—The combination of a leaf having a notched cam, a second leaf hinged to the first leaf and provided with a guide socket, a locking bolt guided in said

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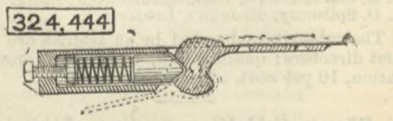

socket, a disc guided in the socket, a spiral spring interposed between the locking bolt and disc, and a set screw bearing on the disc for adjusting the tension of the spring, substantially as set forth.

EXPRESS ENGINE, EMPEROR FERDINANDS NORTHERN RAILWAY AUSTRIA.

(For description see page 65.)