SIMPLE FORMULÆ FOR STEAM ENGINE CALCULATIONS.

By Professor W. C. Unwin.

Probably in no branch of science are the relations of the quantities involved more accurately established than in thermo-dynamics. The laborious researches and the brilliant generalisations of Joule, and Rankine, and Clausius, and Zeuner, and Hirn, have placed the theory of the steam engine almost at the head of physical problems completely subjected to understood mechanical principles. But more than this: Long ago the accurate and remarkable experimental researches of Regnault, almost unexampled in completeness and carried out with exceptional resources and with unchallenged manipulative skill, determined all the physical data necessary for the application of the theory to various conditions of actual work. In fact, the whole action of steam in the steam engine can be reduced to exact calculation so far as the conditions existing in the engine can be precisely assigned. That there is still somewhat of a gap between the thermo-dynamical theory of the steam engine and the facts of experiment and experience, is due to complexities, introduced by such causes as leakage at valves or piston, of which quantitative estimation is impossible, or still more to such causes as the as yet imperfectly understood action of the conductivity of the walls of the vessels in which the action of the steam occurs. It is not to these more recondite obstacles in the path of the student of thermo-dynamics that the present paper refers, but to a much smaller and less important, but still irritating, obstacle to progress, and that is the inconvenient form of the expressions for the physical laws on which every calculation depends. In spite of the completeness of the theory and the adequacy of the determination of the physical data, the laboriousness of thermo-dynamical calculations is greater than that of any other kind of engineering problem. The whole theory of elasticity, for instance, rests on the simple law that stress is proportional to strain, and having determined two or three constants for each material, every ordinary problem can be solved. But in thermo-dynamical calculations we cannot fall back on equally simple data or an equally rational rule.

The relations of pressure, temperature, and volume, which form the necessary experimental basis for calculations in thermodynamics, are at present—except for gases—expressed only in empirical formulæ of inconvenient form. Most treatises contain quite a small number of independent empirical expressions, about the trustworthiness of each of which a student must satisfy himself separately, and from amongst which a selection of one has to be made in each case which arises. If this is to some extent unavoidable, it may be granted it is embarrassing, and it is worth examining how the difficulty can be minimised.

Relation of pressure and temperature of saturated vapour.—In a very large number of calculations we require to know the relation of the pressure and temperature of saturated vapour. For this relation no rational law is known. Regnault's researches supply data extending over a range of temperature from − 30 deg. to + 432 deg. C., a range in excess of practical requirements. But we can only make use of these data conveniently when they are embodied in a formula. For practical calculations an empirical formula would satisfy all requirements, provided only it fitted the data with accuracy sufficient for practical purposes. Adopting a suggestion of Biot, Regnault found a formula which fits the experimental data with quite remarkable exactness. That formula is of the form

$$\log. p = a + b\,\alpha^t + c\,\beta^t$$

where p is the pressure and t the temperature reckoned from an arbitrary zero. If all that was necessary were the determination of p from t, Regnault's formula would answer all purposes in spite of its rather inconvenient form. But this is by no means the case. Regnault's formula does not help us to get t when p is known, and although Zeuner with very great labour has calculated values of $\frac{dp}{dt}$, the calculation is too laborious for ordinary engineers or for students. A simpler formula, and one nearly as exact, was obtained by Rankine, in part from a theoretical investigation which he terms the centrifugal theory of elasticity. But he was obliged to add an empirical term to his equation to make it fit the data. Rankine's formula is

$$\log. p = a - \frac{\beta}{t} - \frac{\gamma}{t^2}$$

where t is the absolute temperature. This equation gives an inverse quadratic expression for t in terms of p, though not a very convenient one, and the value of $\frac{dp}{dt}$ though cumbrous, is more easily used than that derived from Regnault's formula. (See Rankine's Scientific Papers, p. 422). Long ago Hirn pointed out that, as for saturated vapours there is a definite specific volume v for any given pressure p or temperature t, any one of these quantities must be a function of either of the other two without reference to the third. But with Rankine's equation we cannot express in any simple form the necessary functions of pressure, temperature, and volume in terms of one of these quantities simply. For instance, Rankine gives

$$t\frac{dp}{dt} = 2{\cdot}3026\,p\left(\frac{\beta}{t} + \frac{2\gamma}{t^2}\right)$$

where both p and t appear on the right-hand side. We cannot replace p without making the form of the equation unmanageable.

Of course no absolute difficulty arises. The calculations can be made though with some labour. But the awkwardness of form of the original empirical equation does introduce some complexity in the calculation, and in the case of students some confusion of ideas. That this is so appears from the fact that all treatises on the steam engine contain somewhat extensive tabulated values of the functions t, p, $\frac{dp}{dt}$, ... required. Such tables reduce very much the arithmetical labour of calculation and conduce very greatly to accurate work. But it must be remembered that in using such tables recourse must generally be had to interpolation, and that increases the labour and somewhat diminishes the accuracy of the calculation.

Now in all practical calculations there is a degree of accuracy which must be attained, and a refinement of accuracy which is entirely unnecessary. The observations on which calculations must be based, the steam gauge pressure, the indicator diagram area, the measurement of the feed-water and the condenser discharge, and so forth, are themselves accurate only to a certain degree of approximation. Hence it appeared that something of the extreme accuracy of Rankine's or Regnault's equation for the relation of p and t might well be sacrificed, if only an expression could be found, simple enough to be introduced into the various thermo-dynamical equations to reduce them to a form in which they could be easily calculated.

The author has given such an expression in a paper read before the Physical Society, with a detailed comparison of the values it gives with the values obtained by much more laborious calculations. For that comparison it was convenient to use Zeuner's tables, in which the presssures are in mm. of mercury and the temperatures in Centigrade degrees. Here it is only proposed to give the formulæ in English measures, with a few calculations sufficient to show their degree of accuracy to practical engineers.

Formulæ for the pressure and temperature of saturated steam.—The equation which will be used is of the form—

$$\log. p = a - \frac{b}{t^n} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

which gives the inverse formula

$$t = \left(\frac{b}{a - \log. p}\right)^{\frac{1}{n}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1a)$$

Let p be the absolute pressure in pounds per square inch, and t the temperature reckoned from − 461 deg. Fah. Then the constants which seem most suitable for the range of temperature in steam engine calculations are—

$$\log. p = 5{\cdot}8031 - \frac{15{,}900}{t^{1{\cdot}25}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

the logarithm being a common logarithm—

$$t = \left(\frac{15{,}900}{5{\cdot}8031 - \log. p}\right)^{0{\cdot}8} \quad . \quad . \quad . \quad . \quad (2a)$$

The following table gives a few values calculated by these equations and the corresponding values in the carefully calculated table in Cotterill's "Steam Engine."

Temp. Fah.	Temp. absol.	Pressure in pounds per sq. in.	Pressure by Eq. (2).	Error of Eq. (2).	Temp. by Eq. (2a).	Error of Eq. (2a).
100	561	0·942	0·953	+·011	560·7	−0·3
150	611	3·707	3·706	−·001	611·0	0
212	673	14·70	14·62	−·08	673·3	+0·3
250	711	29·88	29·67	−·21	711·5	+0·5
300	761	67·22	66·82	−·40	761·4	+0·4
350	811	135·11	134·62	−·49	811·4	+0·4
400	861	247·75	247·70	−·05	861·0	0
432	893	350·73	351·50	+·77	892·8	−0·2

Here the agreement from 1 lb. absolute per square inch up to 350 lb. per square inch is amply sufficient for practical calculations. The error in no instance reaches 0·7 per cent. of the value sought, and is generally much less. It is not, however, for this relation between p and t that a formula is specially required. It is in simplifying other functions that the new expression is most useful.

Thus, differentiating Equation (1) we get

$$\frac{1}{p}\frac{dp}{dt} = 2{\cdot}3026\,\frac{n\,b}{t^{n+1}}$$

and introducing numerical constants we get the equivalent equations

$$\frac{1}{p}\frac{dp}{dt} = \frac{45{,}765}{t^{2{\cdot}25}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$= 0{\cdot}0012532\,(a - \log. p)^{1{\cdot}8} \quad (3a)$$

Multiply this by t, and we get

$$\frac{t}{p}\frac{dp}{dt} = \frac{45{,}765}{t^{1{\cdot}25}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$= 2{\cdot}8783\,(5{\cdot}8031 - \log. p) \quad . \quad (4a)$$

This is a frequently used quantity in thermo-dynamical calculations. It is the ratio of the latent heat of vaporisation to the heat expended in external work. Professor Cotterill has given in Table V. of "The Steam Engine," values calculated from Rankine's equation. These will serve to check the accuracy of the equation.

Pressure. lbs. per sq. in.	Values of $\frac{t}{p}\frac{dp}{dt}$ By eq. 4a.	By Rankine's formula.	Error of Eq. 4a.
250	9·80	9·75	+·05
200	10·08	10·03	+·05
140	10·53	10·49	+·04
70	11·39	11·36	+·03
40	12·09	12·08	+·01
20	12·96	12·98	−·02
10	13·83	13·88	−·05
5	14·69	14·79	−·10

The quantity which Professor Cotterill calls the ratio of the internal work pressure to the pressure is

$$k = \frac{t}{p}\frac{dp}{dt} - 1$$

$$= \frac{45{,}765}{t^{1{\cdot}25}} - 1 \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

$$= 2{\cdot}8783\,(5{\cdot}8031 - \log. p) - 1 \quad . \quad (5a)$$

from which the internal work pressure is easily calculated.

Formulæ for the latent heat of steam.—It is known that the latent heat of steam at an absolute temperature t is given accurately enough for practical purposes by the approximate equation

$$\mathrm{L} = 1443{\cdot}8 - 0{\cdot}71\,t \quad . \quad . \quad . \quad . \quad . \quad (6)$$

But for some purposes it is convenient to express L in terms of p. The expression obtained is

$$\mathrm{L} = 1443{\cdot}8 - \frac{1632}{(a - \log. p)^{0{\cdot}8}} \quad . \quad . \quad . \quad (6a)$$

where L is in pound-degree units.

Formulæ for the specific volume of steam.—Let v be the volume of 1 lb. of steam and s the volume of 1 lb. of water in cubic feet at the absolute temperature t and pressure p. Then it is known that

$$v - s = \frac{\mathrm{J\,L}}{t\frac{dp}{dt}}$$

From the equations already given, remembering that $t\frac{dp}{dt}$ must be expressed in pounds per square foot, we get,—

$$v - s = \frac{1{\cdot}8626\ \mathrm{L}}{p\,(5{\cdot}8031 - \log. p)} \quad . \quad . \quad . \quad (7)$$

Taking as usual $s = {\cdot}016$

$$v = \frac{1{\cdot}8626\ \mathrm{L}}{p\,(5{\cdot}8031 - \log. p)} + {\cdot}016 \quad . \quad (7a)$$

And the density of the steam in pounds per cubic feet will be the reciprocal of v.

If values of L, calculated by Eq. (6a), are used in obtaining $v - s$ in Eq. (7), both equations may be checked by the values given in Table III. in Professor Cotterill's steam engine.

p lb. per sq. in.	$v-s$ (Cotterill) in cubic ft.	L by Eq. (6a)	$v-s$ by Eq. (7)	Error of Eq. (7) in cubic ft.
250	1·825	831·4	1·820	−·005
200	2·254	845·0	2·248	−·006
140	3·161	865·4	3·149	−·012
70	6·074	900·9	6·056	−·018
40	10·28	926·2	10·27	−·010
20	19·72	954·0	19·73	+·010
10	37·8	978·8	37·96	+·16
5	72·5	1000·8	73·03	+·53

For practical calculations it is accurate enough to take $s = 0{\cdot}016$. Adding this to $v - s$ we get the specific volume v of the steam. The reciprocal of this is the density of the steam in pounds per cubic foot. The following is a comparison of this density calculated from Eq. (7a), with the numbers obtained from Fairbairn and Tate's formula, which is based on their experimental determination of the density of steam. I place also beside these the numbers calculated by Professor Cotterill from Regnault's values of the latent heat of steam.

p Pounds per square inch.	Specific volume by Eq. (7a). v.	Density $\frac{1}{v}$.	Density Cotterill.	Density Fairbairn and Tate.
250	1·836	·5447	·5432	—
240	2·264	·4417	·4404	—
140	3·165	·3160	·3148	—
70	6·072	·1647	·1642	·1682
40	10·29	·0972	·0971	·0994
20	19·75	·0506	·0506	·0512
10	37·98	·0263	·0264	·0263
5	73·03	·0137	·0138	·0126

The following equations are easily obtained:—

External work of evaporation $= p\,(v - s)$

$$= \frac{268{\cdot}2}{a - \log. p}\,\mathrm{L} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

$$= \frac{t^{1{\cdot}25}}{59{\cdot}28}\,\mathrm{L} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8a)$$

Internal work of evaporation $= \overline{p}\,(v - s)$

$$= \left\{772 - \frac{268{\cdot}2}{a - \log. p}\right\}\mathrm{L} \quad . \quad . \quad . \quad (9)$$

$$= \left\{772 - \frac{t^{1{\cdot}25}}{59{\cdot}28}\right\}\mathrm{L} \quad . \quad . \quad . \quad . \quad (9a)$$

In all the new formulæ here given only two fundamental equations are assumed—Equation 2, in which the constants are derived from Regnault's experiments, and Equation 6, which is the usual shortened form of Regnault's equation. All the others are derived quite simply from these two. All the equations are easily solved with the help of logarithms. Of course, if a check or a greater degree of accuracy is required, recourse may be had to the tabulated values in Zeuner or Cotterill.

THE ROYAL INSTITUTION.

UNIVERSAL TIME.

On Friday, March 19th, Professor W. H. M. Christie, M.A., Astronomer-Royal, gave a lecture upon the above subject. Sir William Bowman, F.R.S., presided.

The speaker said that the demand for a system of one time for universal use did not arise as an academical discussion among scientific men, but from the practical want of it felt by certain railway and telegraph companies, more especially the latter. In the Atlantic telegraph offices they are obliged to use clocks with four hands, two red and two black, the former indicating New York and the latter indicating London time. When messages come from places farther west than New York, a calculation has to be made in addition, for it is often of importance to know what messages were started before others. Not long since there were no less than seventy-five different times in use on American railways, and men sometimes missed trains in consequence when they had to change from one line to another. In some parts of Germany local time is so much used that information has to be painted up at regular intervals, to enable the guards of the trains to know the time of each place. So far as matters have gone at present, there is a somewhat general international feeling that the meridian of Greenwich would be the best to adopt universally, simply because it is the one already in use by the navies of every civilised nation. The Americans have declared in favour of the meridian of Greenwich, and set a good example by sacrificing to the general welfare any national susceptibilities on the point. So far as the general public are concerned, the great point is that they should understand that under any new system noon will always be noon, but not necessarily twelve o'clock. When they understand that noon in their locality may be indicated by some other hour than twelve, the pathway for a valuable change will have been laid.

ELECTRO-CHEMISTRY.

On Tuesday, March 25th, Professor Dewar delivered the first of four experimental lectures at the Royal Institution "On Electro-Chemistry." He said that his lectures were to be given in place of four upon "Light" by Dr. Tyndall, who was not at all well, and required a period of complete repose; he was, how-

ever, progressing favourably in health, and there was no doubt that if he accepted the prescription he would soon be quite well again. The lecture was of a preliminary character.

PROPERTIES OF FLUIDS AND SOLID METALS.

On Friday, March 26th, Professor W. C. Roberts-Austen, F.R.S., Chemist of the Mint, lectured upon "Certain Properties Common to Fluids and Solid Metals." Sir William Bowman presided. Among those present were Mrs. Roberts-Austen, Lord Rayleigh, Professor Sylvester, Sir F. Bramwell, Mr. and Mrs. William Crookes, Dr. Rae, Professor Hughes, Mr. H. Trueman Wood, Professor Abel, Mr. Walter Coffin, Dr. J. H. Gladstone, and Dr. James Edmunds.

Professor Roberts-Austen began by drawing attention to the early memoir of Réaumur to the French Academy of Sciences on the ductility and malleability of metals, in which he clearly defined the conditions under which colloid metals would actually flow. The resemblances, said the speaker, between metals and fluids have long been known, and present the following eight prominent points:—(1) Rejection of impurities on solidification. (2) Surfusion. (3) Flow under pressure. (4) Changes due to compression. (5) Absorption of gases. (6) Absorption of liquids. (7) Vaporisation. (8) Surface tension.

In passing from the solid to the liquid state the metals sometimes present the same phenomena as water; for instance, water distinctly rejects impurity to a considerable extent when it solidifies into ice; an alloy of lead, antimony, and copper, on solidifying will reject much of the lead, and take up the remainder. Water may be cooled down to – 8 deg. without actual solidification, but agitation then determines the immediate formation of ice, and the rising of the temperature of the mass to zero is indicated by a thermometer. Faraday stated that sulphur and phosphorus exhibit in their degree the same effects. The master of the Netherlands Mint has proved that gold and silver behave in just the same way. The lecturer here placed a small cup filled with molten gold upon the table in the dark; the metal cooled to dull red, scarcely visible, then at the moment of solidification flashed up brightly, and rose to the temperature of its solidifying point. Gold fuses at 1020 deg., but the slightest trace of silicon will lower the point at which it softens to the melting point of zinc.

In 1726 it was discovered by Louis Lemery that under certain conditions lead exhibits a remarkable property. It is common experience that a spurious silver coin has no "ring," and when a metal is not sonorous, the remark is sometimes made, "It is as dull as lead." In an ancient, and perhaps now generally forgotten experiment, it was discovered that if lead be cast into the form of a segment of a sphere, that is to say, into the form of a plano-convex lens, it will emit quite a sharp note when struck. The speaker illustrated this by experiment, the lead giving a clear tinkling sound. A piece of lead beaten into the same shape with a hammer gave no ring when struck. It was true, he said, that the presence of a trace of impurity conduced to the sonorousness of the cast lead, but he would now strike a piece of chemically pure cast lead, and they would hear that it was sufficiently sonorous to illustrate his point. The conclusion in 1726 was that the phenomenon was due to the way in which the constituent grains of lead touch each other, also to their shape and size. In the recent discoveries on dilatation by Professor Osborne Reynolds there seemed to be something of the same kind; in the case of the lead there was a true flow, and a passage of small particles of matter from one position to another under the hammer. A solid may be very brittle, and yet it will flow; a horizontal stick of sealing wax, supported only at its two ends, will in course of time bend at the normal temperature of the atmosphere, in which phenomenon there is a slow flow of particles; yet let an attempt be made to similarly bend the same stick of wax suddenly, it will snap. M. Tresca, of Paris, by bringing great pressure to bear upon discs of cold lead, forced the lead to flow through a small hole, from which it emerged with a rounded end; when a segment of the issuing jet was cut, the lines of flow could be seen. In the pressing of iron and steel there are lines of flow. Mr. Roberts-Austen illustrated this by means of a crosshead sent to him by Mr. Webb, of the Crewe Works. The lines were made visible by etching. Ruskin had once made the remark that as men stamped the cow upon the butter, why not stamp the bee upon the honey? It simply was not practicable, because honey flows at the normal temperature. The lecturer continued that the most important application in industry with which he was acquainted, connected with the flow of metals under pressure, was suggested by Mr. Baker for the preparation of the steel for the Forth Bridge. He then illustrated the flow of pewter, by pressing a disc of it in a lathe, and showed how Sir Henry Bessemer had made cold-spun ornamental articles from discs of mild steel, 11in. in diameter. On applying tension, he said, to steel or iron, the metal will extend to a certain point, then there is a permanent set, after which it will begin to flow, and continue to flow until it breaks. Standard gold will do the same, but the presence of a "trace" of lead will prevent the "flow" entirely.

Professor Roberts-Austen next drew attention to the experiments of Professor Walter Spring, of Liége, in the submission of cold and powdered metals to immense pressure. The apparatus (which was shown) used consisted of a ponderous lever press, with heavy weights at the end farthest from the fulcrum, as well as the means of applying screw pressure. The little piston which gave the pressure to the powder passed through a gun-metal cap, which had a tap wherewith it was connected to an air pump, so that the air was withdrawn from the interstices of the metallic grains. In 1882 he (Mr. Roberts-Austen) had repeated and verified M. Spring's experiments and results, some of which are set forth in the following table:—

Results obtained by M. W. Spring by the Compression of Finely Divided Metals.

Lead welds at a pressure of			13	tons per	square inch.
Zinc	,,	,,	19	,,	,,
Tin	,,	,,	32	,,	,,
Antimony	,,	,,	38	,,	,,
Aluminium	,,	,,	38	,,	,,
Bismuth	,,	,,	38	,,	,,
Copper	,,	,,	38	,,	,,
Lead flows at		,,	33	,,	,,
Tin	,,	,,	47	,,	,,

When more pressure than fifty tons to the inch is given by the machine, the metals submitted to its action begin to flow through the fine cracks of the compressing chamber, just as if the metals were so much treacle; for instance, when tin filings are made perfectly clean, the interstitial air removed, and then submitted to pressure, they form a solid little cylinder with wings where the metal has streamed into the cracks, as exemplified by the result which he then exhibited. He also exhibited a wire of lead which had been pressed into that form from fine powder, which wire had a breaking strain very little less than if it had been formed by a melting process. M. Spring has proved that it is possible to press powdered crystalline metals into masses of another crystalline structure, just the same as by fusion; also, that it is possible to actually build up alloys by pressure. Were the old alchemists then right in the idea that bodies never combine except when in solution? Experiment proved that solution is not necessary. Chloride of mercury and iodide of potassium are both anhydrous salts; he would triturate them together by means of a mortar and pestle, and they would see that a red-coloured iodide of mercury would be produced. The lecturer then took a little pressed bar, made originally from a mixture of powdered tin, bismuth, cadmium, and lead in suitable proportions, and proved by experiment that those metals had been compressed into a true alloy, which would melt below the temperature of 100 deg., or far lower than the melting point of the most fusible constituent of the alloy. He applied the heat by means of melted paraffin, since the bubbles in boiling water would not have permitted a clear image of the experiment to be projected upon the screen by the electric lantern. It may be argued, he said, that the heat of the compression of the metals sets up incipient fusion. M. Spring had pointed out that the pressure was applied with extreme slowness, and that if all the work were translated into heat that heat would not be sufficient to account for the result. M. Spring had also by direct experiment given evidence that the heat was below 28 deg., and he had asked—Is the union of the metals due to regelation? Faraday discovered in 1850 the regelation of ice, which had enabled Dr. Tyndall to render splendid service to science by furnishing the key to the explanation of the nature of the movements of vast masses of ice, for glaciers owe their motion not to viscosity, but to regelation. Bismuth is a metal which exhibits the phenomenon of regelation. It is difficult to believe, said M. Spring, that ice alone possesses the property of regelation; give other bodies the same relative conditions—give them the necessary pressure, temperatures, and times, will not the same results be evolved? The grains of powdered nitrate of soda or phosphate of soda in a bottle will slowly unite. May there not, however, said the lecturer, be in the compression of gases an analogy to the liquefaction of gases? In gases the molecules are free, but by pressure they are condensed into liquid form by being brought into spheres of mutual action, and metal, by being powdered, may be said to be coarsely gassified. He regretted that the time allotted for lectures would not permit him to enter into all the particulars he desired to give, but he would add that metals like liquids could not only be vaporised, and would absorb gases, but exhibited something like surface tension. He here took a thick horizontal wire of an alloy of gold and silver, resting upon its two ends, and merely touched its centre with a soluble chloride; after the lapse of a minute or two the surfaces of the thick wire cracked, and in such a manner as to suggest surface tension. Mr. Fletcher, he said, had first pointed this out to him. Professor Roberts-Austen then concluded by pointing to the influence of the facts they had considered on art, on science, and on industry.

LETTERS TO THE EDITOR.

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

WORKSHOP DRAWINGS.

Sir,—I have read with great interest the letters which appeared in your issues of March 19th and April 2nd, on "Workshop Drawings," and I quite agree with your correspondents who assert that draughtsmen are looked upon merely as men who draw machines, and not as engineers. Only a few days ago I heard of a little conversation which had taken place about myself. One of the principals in the works was asking if I had had any practical experience in the works, and on being informed that I was a practical mechanic as well as a draughtsman, remarked, "Oh, I thought he was only a draughtsman, not an engineer." One thing which I am constantly being troubled with, and to which I have a very great objection, is being asked for "just a rough sketch, &c." Now I look upon giving rough sketches as a great waste of time and money in the long run, for it is only natural that some detail is overlooked in a sketch, and this necessarily means alterations to patterns, &c. I argue that "a thing worth doing at all is worth doing well." An "Ex-Draughtsman" justly says that the fittest person to supervise the erection of a machine is the man who designed it. This is all very well when it can be done, but when the foreman will not be told how to do a thing, and persists in doing it in his own way, and informs the manager that you "don't know what you are talking about," how about the supervision then? This is another of the many difficulties I labour under in these hard times, and I have many a time to show the manager myself, when I know that the foreman has been informing him of a mistake, that I am right, and he is the man in whom the ignorance lies. I have positively had to inquire how it was possible for me to make a general plan of a machine, consisting of several tanks, &c., without seeing the way in which the all-powerful foreman had chosen to erect it. Is this state of things to go on, or is the draughtsman to have his drawings carried out, and get the credit of a good job which is due to him? and are employers going to learn that it is cheaper to pay more for a good draughtsman, than it is to have an inferior man and let him be at constant war with the foreman? and is the foreman going to learn that he must carry out the draughtsman's plan precisely, and not think that he knows better?

London, April 5th. Scale.

DR. OTTO'S CLAIMS AND THE KORTING GAS ENGINE.

Sir,—In your issue of last week we saw a letter from Mr. F. W. Crossley with reference to our gas engine. It was stated there that we had been again obliged to defend ourselves against an action for infringement brought by Dr. Otto. Anyone can bring actions for infringements of his patents if he has money enough to pay the costs, but it is only possible for him to win such actions when he has law and right on his side. Therefore, the bare fact that Dr. Otto is attacking us again proves nothing.

According to the judgment of the Reichsgericht, Dr. Otto has really made no invention, but a combination of known parts, and only a definite combination of a certain number of such parts remains his patent. The principal detail is the introduction or the mode of drawing mixtures of varying strength into the cylinder. An engine which does not do this is, according to the very clearly expressed judgment of the Reichsgericht, completely free from Otto's claim. Our engine in this respect is constructed quite differently, as may be seen from the description and illustration of our patent mixing valve in your issue of the 26th inst.

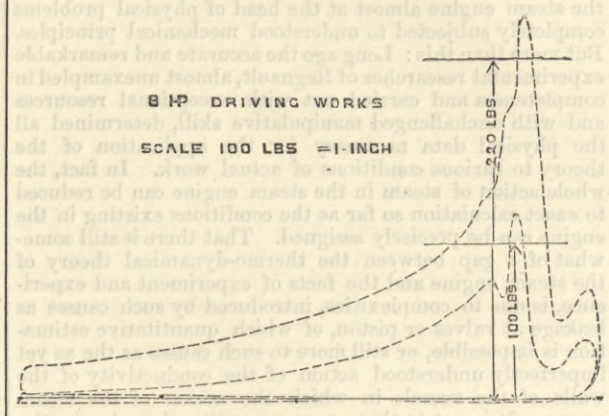
Any attempt to call Körting's engine an infringement of Otto's German patent, as it now remains, is certainly without the slightest foundation either in law or justice. The judgment of the court in the action referred to by Mr. Crossley, which will be delivered very shortly, will certainly convince Dr. Otto of this.

We should be obliged if you would give publicity to this letter.

11, Pancras-lane, Queen-street, *Pro* Körting Bros.
London, E.C., April 7th. Otto Lindemann.

GAS ENGINES.

Sir,—May I ask you to kindly correct a slight mis-statement in your article on the Körting-Lieckfeld gas engine which appeared in your last issue. In the description it states: "Messrs Körting Brothers have devised a method of obtaining regularity in the speed without in any way interfering with the economical working of the engine—a result which has never before been attained." If you will kindly refer to the notice you gave of our horizontal engine, you will there see that I had previously attained the same object; the 3½-horse power engine we showed at the Inventions Exhibition last year was governed so as to give a working stroke every revolution, with its intensity controlled infallibly by the automatic governor, and the required amount of charge delivered into the working cylinder so as to maintain uniform speed under the most varying load, the reduced charge, however, not being weakened or partially neutralised by an excessive amount of residuum, as it must be in Messrs. Körting's arrangements; for in our engine we drive out the residuum as completely as possible before admitting



any explosive mixture. As seen by the diagrams, which show a full-power stroke and about a half-power stroke, it will be seen that in the half-power stroke the expansion line runs down to atmospheric pressure, and the whole expansive force of the ignited charge is utilised. In fact, under these conditions the gas is more usefully burned than when the engine is giving full power; also the power required by the compressing pump is reduced in proportion.

As facts are worth more than statements, I may mention that we have an 8-horse engine working in London—which I should have pleasure in showing you at any time—that sometimes runs for hours without making a single working stroke much above half power, and never failing to make a working stroke per revolution. It burns on an average 86 cubic feet of London gas per hour. I cannot exactly estimate the power given out, but the engine replaces a 3½-horse gas engine which drove the work for years, but was ultimately too small. We were fortunate enough to obtain the order from the fact of being able to give a regulated working stroke per revolution, as regular turning was of the utmost importance, the engine having to drive machinery for weaving figured ribbons, gold and silver lace, &c. This desired regularity is attained as perfectly as it would have been by a steam engine with a modern governor of the best type; also the above-mentioned gas consumption proves its economical working.

Messrs. Körtings' method has been carried out in a much more satisfactory manner by Messrs. Crossley Brothers, who, in engines for special purposes, sometimes make the gas admission valve to open earlier or later, so that the relative proportions of the air only, and of the gas and air drawn in, vary according to the power required, the amount of residuum remaining the same. The gas is thus more likely to be usefully burned than if it was more closely associated with residuum. Both these methods have, however, been proved by experiments to be less economical than burning a rich mixture of gas and air only, and my endeavour in all my different types of engines has been to get rid of the residuum as thoroughly as I possibly could. Messrs. Crossley Brothers, in the majority of their engines, only adopt this method of regulation to a very limited extent, if at all—thus showing how little they believe in its efficiency.

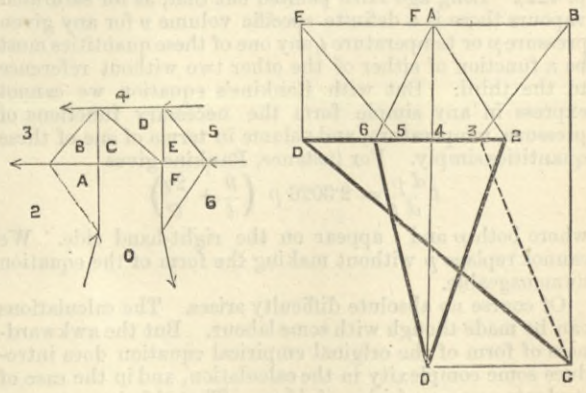
James Atkinson,
Albion Works, Mansfield-road, Managing Director to the
London, March 31st. British Gas Engine and Engineering Company.

AMERICAN BRIDGES.

Sir,—Mr. R. H. Graham has given up his equation between + M and – M. He has also got the length of seeing that the points O and C in my stress diagram in your issue of 12th ult. are determinate in position, and independent of the shape and size of the triangles used to truss the column beams with. But he now states that the difference between two infinite lengths is necessarily zero. Thus O and 4 being two fixed and definite points, and F being a point on the same line O 4, which—point F—may recede to an indefinite distance, he concludes that O F – 4 F = O. Ordinary mortals, even those who had not gone beyond the first elements of geometry, would say it equals O 4, but Mr. Graham's conclusions seldom agree with those of common sense. Such a mistake would not be made by a schoolboy who had passed the third standard.

Mr. Graham tries to evade a charge I made against him by misrepresenting it. He says that I "charge him with attacking Prof. Waddell in his absence." I made no such charge. If Mr. Graham had really been able to point out errors in Prof. Waddell's book, I should have thought him quite right to peint them out, no matter how many thousands of miles Prof. Waddell is away. But in attacking Prof. Waddell, Mr. Graham made two most egregrious blunders, which I pointed out, Prof. Waddell being, in reality, perfectly right. In reply, Mr. Graham endeavoured to shift the responsibility of these blunders on to Prof. Waddell's shoulders, without any justification in fact for his doing so. It was this last manœuvre that I condemned as unworthy—not the original attack.

Mr. Graham also strongly "objects to Professor Smith taking an axe and ruthlessly chopping away his bracing." He does so, however, only because he does not understand the method I gave nor the meaning of the resulting diagram. I did not explain it in detail in my first letter, because I thought it would be at once understood. Since it has not been understood, I will, with your permission, now give the detailed interpretation of the diagram, for which purpose I must ask you to be kind enough to reproduce it.



At the foot of right-hand column we have balance between the force 60 exerted by the foundation, and 06—equal and opposite—exerted by the column. The former 60 may be looked on as the resultant of the horizontal component 64, and the vertical component 40. The latter 06 is *obtained* in the diagram by compounding 0 F and F 6, the stresses along the links 0 F and F 6 of the

imaginary trussing. But these components are only imaginary ones introduced for the sake of getting their resultant. The resultant is the only *actual* force we have to deal with. But this resultant 06 is conveniently considered as made up of the two components 04 and 46. The former 04 indicates the tension along the lower part of the column, which it exerts as a tie bar would. The latter 46 is the horizontal shear on the column section, which it exerts in virtue of its being a beam, and which—in other words—represents its transverse beam-resistant force at this point. The balance of forces at the foot of the left-hand column is quite similar, and does not need separate explanation.

Coming now to the joint O C D E F, that is the joint at middle of right-hand column, the balance here is in the diagram, including "imaginary" stresses, represented by the polygon O C D E F O. The *actual* stresses, however, are O C, C D, D 5, 56, and 60. Of these O C is the *actual* thrust along the bar of the same name. C D is the *actual* tension along the oblique bracing rod C D. D 5 is the horizontal shear of the beam immediately above the point of application of the wind force 56; or in other words, the horizontal resisting thrust, the column at this point exerts as a beam. There is no tension in the upper part—named D E—of the column. This D 5 is the resultant of the two forces D E and E 5 acting on a section above the joint through the truss imagined substituted for the column. The fourth force acting here is 56, the wind force. The last force is 60, which is exerted at this joint by the lower part of the column, being due first to the tension 40 in this part of the column, and second to the shear force 64 also exerted by the column immediately below the point of application of the wind force 56. The two shear forces D 5 and 64 exerted by the column above and below the joint differ by the algebraic sum of the three other horizontal forces acting at this joint—namely, O C, the horizontal component of C D, and the wind force 56.

At the joint at top of right-hand column we have the *actual* stress D 4 on the bar of same name, the wind force 45, and the shear 5 D of the column. This latter is *obtained* by compounding the two imaginary stresses 5 E and E D, but these have no real existence, the only actual stress being the transverse beam thrust or shear 5 D.

The interpretation of the stress diagram for the two remaining joints in the frame is so similar to those already detailed that I need not occupy more of your space in giving it.

Note that the diagram gives the tension in the column uniform from base up to first joint. This results from neglecting the weight of the column and other bars of the frame. Actually, of course, the tension at top of D E is *greater* than at foot of same length by the weight of this length of column. Mr. Graham's notion that it *decreases* from the foot to half its lower value at the top is as absurd and erroneous as his other ideas.

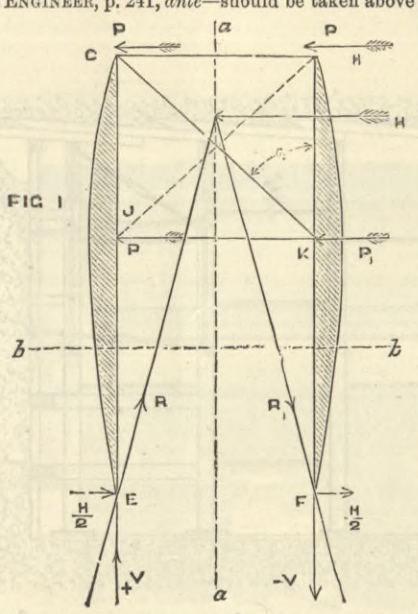
I have worked out the problem graphically on Professor Waddell's hypothesis, which Mr. Graham accepted in his critique. Of course, every one knows that that hypothesis is only approximately correct. Every one knows that at the base of each column taken separately there is in every actual structure a bending moment under wind stress, but it is here neglected as being comparatively small.

ROBERT H. SMITH.

Mason College, Birmingham, April 6th.

SIR,—In reference to the question of a partially braced cantilever, it is suggested by Mr. Graham that a section similar to *b b*—Fig. 1, THE ENGINEER, p. 241, *ante*—should be taken above J K, and

FIG. 1



the equilibrium of the cantilever at that section tested. This may readily be done, and will complete the analytical investigation of the problem.

Referring to Fig 1, imagine a section *c c* to be taken above J K, and parallel to it, cutting the three bars C J, C K, H K at a depth x_1 below C H. The posts C J E, H K F are in the condition of beams supported horizontally at the points J, K, acted upon at their lower ends E, F by equal forces $\frac{H}{2}$ with the moment arm $d - f$, and kept in equilibrium by horizontal forces at their upper ends C, H acting with the moment-arm f, and each equal to—

$$F = \frac{H}{2} \cdot \frac{d-f}{f}.$$

Between the points C J and H K there is, therefore, a constant shearing force equal to F on the cross section of each post, the direction of which on the upper side of such section is the same as that of the forces $\frac{H}{2}$.

Consider the horizontal forces acting upon the segment of the cantilever above the section *c c*. The sum of the external wind forces is 2 P;
the sum of the shearing forces on the under side of the cross sections of C J, H K is—

$$2F = H \cdot \frac{d-f}{f},$$

acting upon the upper segment in the same direction as 2 P;
the horizontal component of the stress in C K is—see p. 241 *ante*—

$$\begin{aligned} S_2 \sin.\ \theta &= -\frac{1}{f}\left\{H d - 2 P_1 f\right\} \\ &\approx -\frac{1}{f}\left\{2(P + P_1) d - 2 P_1 f\right\} \\ &\approx -\frac{1}{f}\left\{H(d-f) + 2Pf\right\}, \end{aligned}$$

acting upon the upper segment in the direction opposite to 2 P.

The algebraic sum of the above forces is—

$$2P + 2F + S_2 \sin.\ \theta = o,$$

showing that the condition of equilibrium of horizontal forces at the section *c c* is satisfied.

Further, consider the moments of all forces acting upon the segment above *c c*. The moment of the external wind forces is $2 P x_1$;
at the cross section of each post where cut by *c c* a bending moment occurs—see page 241, *ante*—

$$m_1 = \frac{H}{2} \cdot \frac{d-f}{f} x_1,$$

tending to cause rotation of the upper segment in the same direction as the first-mentioned moment.

The vertical component of the stress on C K is—

$$\begin{aligned} S_2 \cos.\ \theta &= -V \\ &= -\frac{1}{b}\left\{H d - 2 P_1 f\right\} \\ &= -\frac{1}{b}\left\{H(d-f) + 2Pf\right\}, \end{aligned}$$

and it acts with a moment arm with respect to the intersection of *c c* and C J, equal to the intercept on *c c* of C J, C K—that is,

$$x_1 \tan.\ \theta = x_1 \cdot \frac{b}{f};$$

the moment of S_2 is therefore

$$m' = S_2 \cos.\ \theta \cdot x_1 \cdot \frac{b}{f} = -\frac{x_1}{f}\left\{H(d-f) + 2Pf\right\},$$

tending to cause rotation of the upper segment in the opposite direction to the wind forces and the moments m_1.

There is no direct stress on H K, and C J passes through the axis of moments; there are, therefore, no other forces to be considered, and the algebraic sum of the above moments is—

$$2 P x_1 + 2 m_1 + m' = o,$$

showing that the condition of equilibrium of moments at the section *c c* is satisfied.

Mr. Graham now refuses to accept Professor Waddell's assumption that the whole horizontal wind force is transmitted by the cantilever to the lower system of bracing; but in his paper of March 5th that condition was not disputed, and one at least of the results following from it, the value of V, was accepted by him. Without that assumption, indeed, the problem ceases to exist, as the braced panel is no longer a cantilever, but an imperfectly braced girder connecting the upper and lower systems of bracing. On no assumption whatever can local bending moments at E, F be taken into account, since they only exist through the rigidity of connection of the posts to the lower booms, and the resistance of the latter to torsion, which must be small in comparison with the moments of the wind forces.

Referring to Professor Smith's stress diagram in THE ENGINEER, March 12th the direct stress V on the posts of the actual cantilever is represented by O 4; the lines O A, O F representing the stresses on the lower parts of the posts only on the supposition that the imaginary wing trusses have a real existence.

Your correspondent, Mr. W. B. Coventry, is no doubt satisfied as to the fact that the direct tension on the post F H is constant from F to K and equal to V, and is *nil* above K, having been wholly taken up by the diagonal C, K.

Graphic statical methods are now of great importance in applied mechanics, and enable problems to be dealt with which are beyond analysis. It is essential, however, whether graphic statics or analysis is to be used, that the data of a problem be clearly stated and sufficient for its solution, since no method, however powerful, can make good deficiency in such respect.

H. REILLY.

April 5th.

SIR,—Mr. Graham's letter in THE ENGINEER of the 2nd inst. contains the following statement:—"The assumption that the shearing force can leap the unbraced panel and reach the feet E and F without giving rise to local bending moments at those points is simply preposterous." Will you allow me to remark that it would be quite as absurd to say that a beam A B resting on two supports A and B, and carrying a weight W at the centre of the span, cannot transmit the shear $\frac{W}{2}$ to the supports without giving rise to bending moments in the beam at those supports—the mechanical principle involved is in each case precisely the same. Unless the ends of the beam or the feet of the posts are fixed, *i.e.*, rigidly connected with the supports, there cannot be any bending moments at those supports.

Your correspondent "Juventus" complains that Professor Smith does not give a solution of the problem which satisfies Mr. Graham; but this seems to me somewhat unreasonable, as it is obviously impossible that the correct solution of the problem should satisfy anyone holding the doctrine enunciated in the statement I have quoted above, or that to which I drew attention in my letter last week.

W. B. COVENTRY.

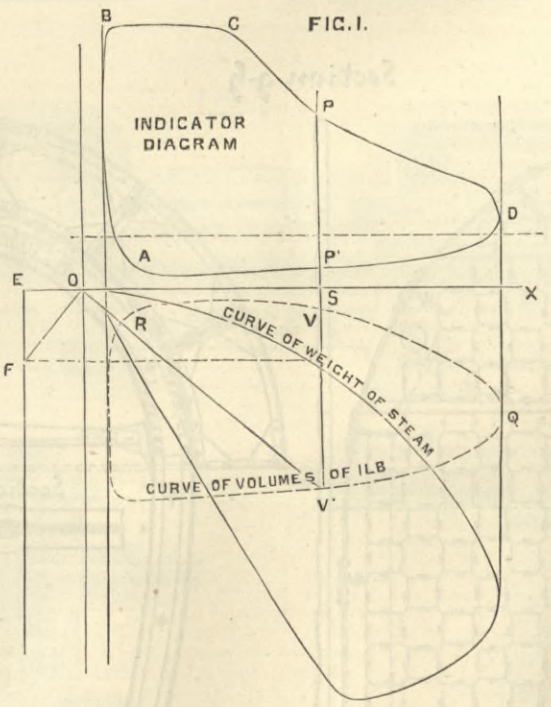
Cardiff, April 3rd.

CONDENSATION OF STEAM IN CYLINDERS.

SIR,—I have observed among the various writings and articles upon this subject that a very simple method of exhibiting the "weight of steam recorded per indicator" by means of a diagram derived from the ordinary indicator diagram is never employed, and that investigators usually content themselves by stating the quantity of water recorded at one, or at most, two points in the stroke. I enclose a specimen of what may be called the "water diagram" of an engine—Fig. 2—made by an almost purely graphical process.

In Fig. 1, which is not drawn to scale, let A B C D be an indicator diagram, O X being the line of absolute vacuum, and O X being made equal to stroke + clearance, then with the aid of a table of volumes of steam construct the auxiliary curve R V Q V^1 by taking on any ordinate S P, S V, and S V^1 on any arbitrary scale to represent the volumes of 1 lb., or the relative volumes at the

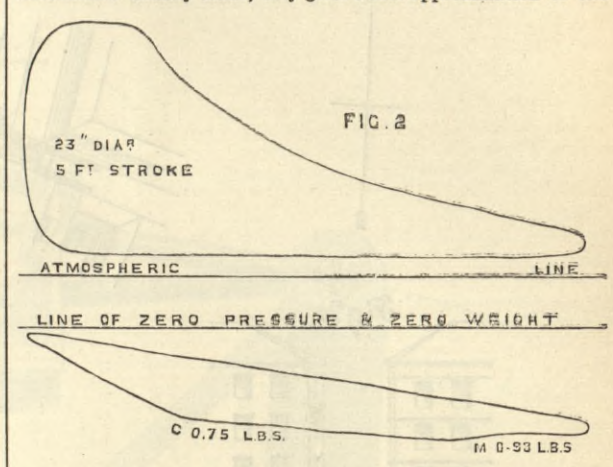
FIG. 1.



pressures S P and S P^1 respectively. Then since O S represents the actual volume in the cylinder at the point of the stroke represented by S, and S V^1, say, represents the volume of 1 lb., the weight of steam—supposed saturated—contained in the cylinder will be represented by the ratio $\frac{O S}{S V_1}$. If, therefore, we draw O F perpendicular to O V^1, meeting a vertical E F in F, then by similar triangles $\frac{O S}{S V^1} = \frac{F E}{E O}$, and we only require to determine E O so that the scale for F E shall be a convenient one, which can be done by calculating the weight of steam of any one point on the diagram, and drawing F E at such a distance from O that it shall represent on the desired scale the calculated weight. Then the distance on F E below O X to F for any other ordinate on the diagram will represent the weight of saturated steam in the cylinder at that point.

Fig. 2 is the result as applied to an actual case, in which the increase of water recorded during expansion is very marked, being from 0·75 lb. at cut off, marked C, to 0·98 lb. at M, near the termination of the expansion. Of course, such a diagram, or the calculations usually made, only gives a first approximation to the

FIG. 2



quantity of water actually consumed, being made on the hypothesis that the steam is saturated. In this case, for example, it appears that at cut off—still supposing the steam to be saturated—the heat units from 32 deg. contained in it were 0·75 lb. × 1177 = 882·5, at M there were 0·98 × 1162 = 1139, and the work done by the indicator diagram between these points was equivalent to forty-one heat units, hence there must have been at least forty-one heat units, plus the difference between 1139 and 882 in the cylinder at the point of cut off. This is 298 units, which would have sufficed for condensing 0·32 lb. from and at the boiler pressure, taken as 70 lb. above the atmosphere; we must therefore, if this supply of heat was to be imparted to the cylinder during admission, add 0·33 lb. to the 0·75 lb. recorded at cut off, which makes the total weight of steam admitted 1·08 lb. at least, instead of 0·98 lb. recorded as maximum by the indicator. If, however, the heat required for performance of work were supplied by the jacket this must be reduced by about 0·03 lb., which would be then condensed in the jacket instead of in the cylinder, still leaving about 10 per cent. of the total water admitted, as directly recorded, which must have remained unevaporated at the end of the stroke.

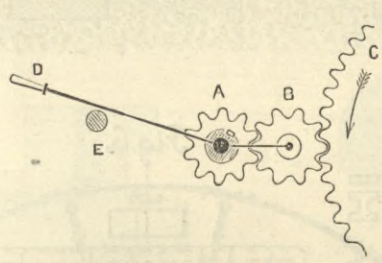
In fact it would be easy to construct a "heat diagram" derived from the "water diagram" by multiplying each of its ordinates by the total heat at the corresponding pressure, and adding to each ordinate so obtained the units of heat corresponding to the total work of the engine, as per indicator diagram, up to that point. Such diagrams, however, though very interesting from a theoretical point of view, are of less immediate practical value than the "water diagram," which seems to me in many ways to be more readable—if the expression may be used—than diagrams showing the difference between the actual expansion line and a hyperbola or other curve like $P V^{\frac{n}{\varphi}} = \text{constant}$. The "water diagram" curve is, properly speaking, the curve of equivalent weight of saturated steam, in the other cases the power to which V is raised in the expression $P V^n = \text{constant}$ involves a set of assumptions more or less obscure, depending on a set of experiments made under much more complicated conditions than those of Regnault and others on saturated steam, so that the difference of the actual from the experimental conditions in any practical case is much more difficult to allow for, and, which is often more important in drawing conclusions, is much more likely to be forgotten altogether.

MAURICE F. FITZGERALD, A.M.I.C.E.

Queen's College, Belfast,
March 30th.

BARRING ENGINES.

SIR,—Considerable attention has been recently directed to the subject of barring engines and patent safety turning gears; several examples have been described in your columns, but I have not seen any mention made of Harfield's turning gear, patented February 15th, 1872, No. 483. The term—fourteen years—for which this patent was granted has expired, but a description of the gear may nevertheless be interesting to some of your readers.



The device, which is shown in the annexed sketch, consists of swinging arm, with two pinions on the sun-and-planet arrangement. The sun pinion A is keyed on a driving shaft, and on this shaft the arm is hinged or centred; one end of the arm carries the planet pinion B, which gears into A, the other end D of the arm serves as a hand lever, C is the wheel to be turned. When this operation has to be performed the shaft which carries the pinion A is set in motion and the lever D is depressed till it comes in contact with the stop E carried by the framing of the machine. The pinion B is then in gear with the wheel C, which it turns in the direction indicated by the arrow. When the wheel C commences to turn by itself, and so becomes the driver instead of being driven, it throws the pinion B down and out of gear.

March 30th. A MECHANICAL ENGINEER.

INJECTORS.

SIR,—Referring to the paragraph under the heading "Miscellanea" in your last week's issue, in which it is stated that a German house is "supplying the whole of the injectors for feeding the boilers in connection with the engines at the Colonial and Indian Exhibition," kindly permit us to say through your columns that this is not exactly correct, as the Galloway boilers which supplied steam for the late Health and Inventions Exhibitions will again be used for the Colonial and Indian, and will again be fed with our new patent self-acting re-starting injectors, which received the highest award at the Inventories.

GRESHAM AND CRAVEN.

Manchester, April 6th.

A CORRECTION.

SIR,—In THE ENGINEER of March 12th appeared a patent No. 2964, taken out by me on March 2nd, and which has the address Walter Johnson, *London*. The patent is for Improvements in Heating Domestic Ovens by Gas, and the address should be Walter Johnson, *Leeds*. You might kindly correct this error in your next issue, as it has already affected me.

W. JOHNSON.

Crescent Cottages, Burley-wood, Leeds, April 6th.

[We are not responsible for the error.—ED. E]

[*For continuation of Letters see page* 290.]

TUNNEL FOR FOOT PASSENGERS, STOCKHOLM.

CAPTAIN LINDMARK, ENGINEER.

For description see page 282.)

Fig. 1.

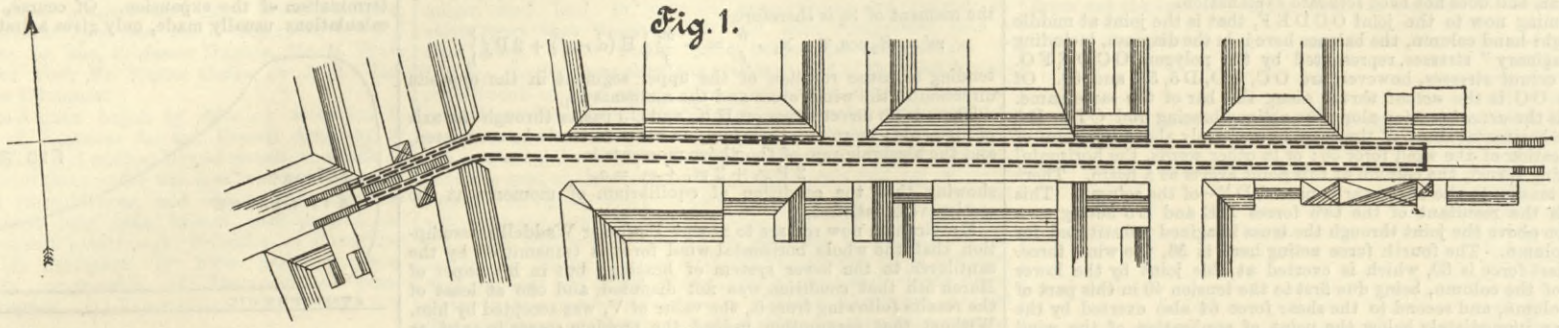


Fig 2.

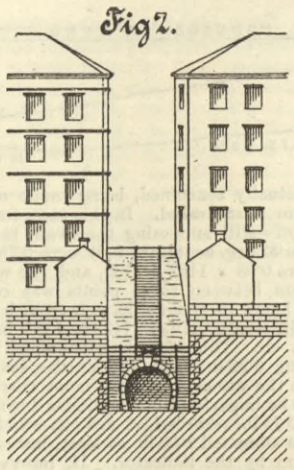


Fig 3.

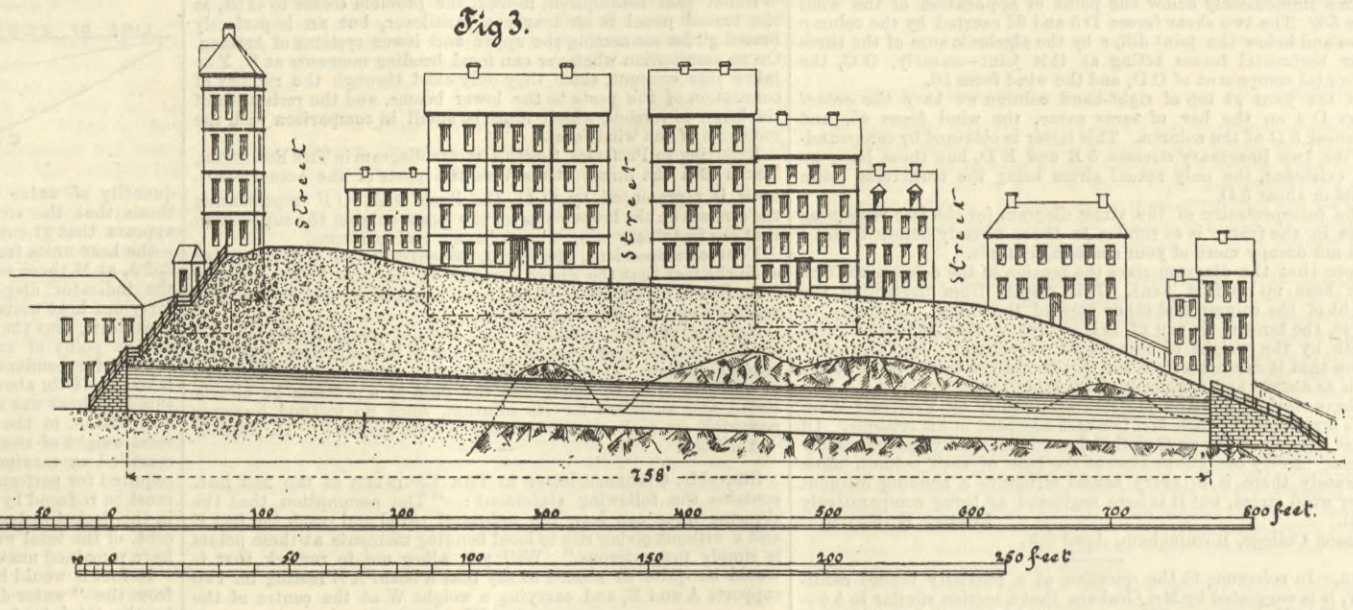


Fig. 4.
Section a-b.

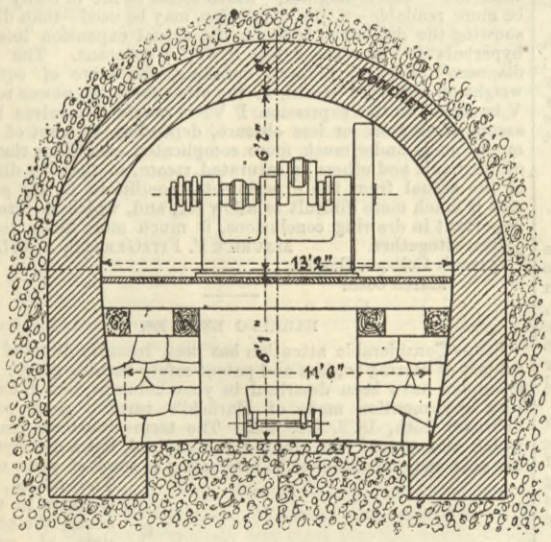


Fig. 5.

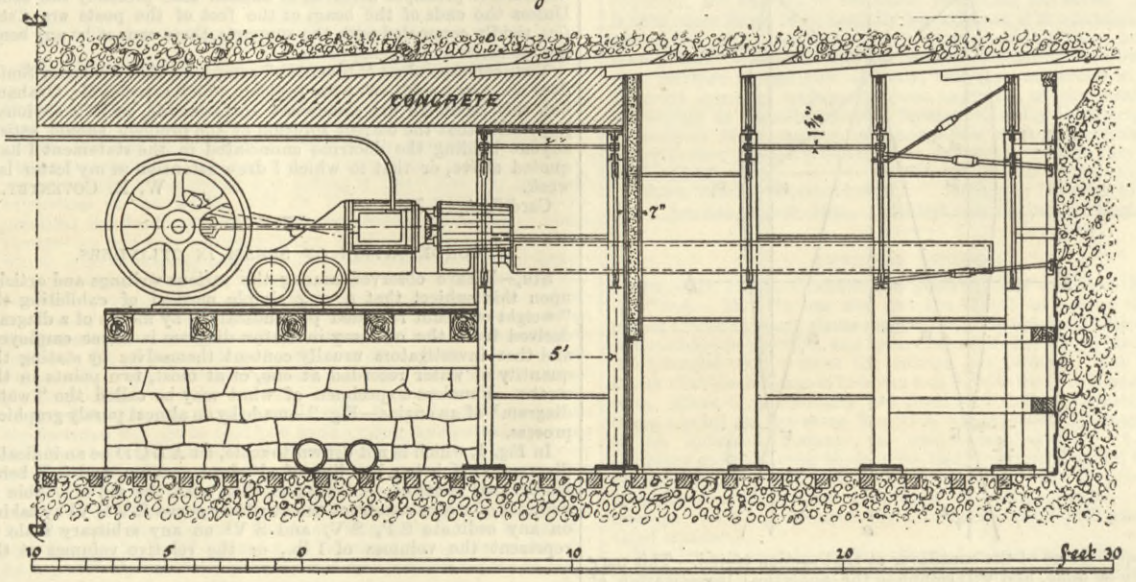


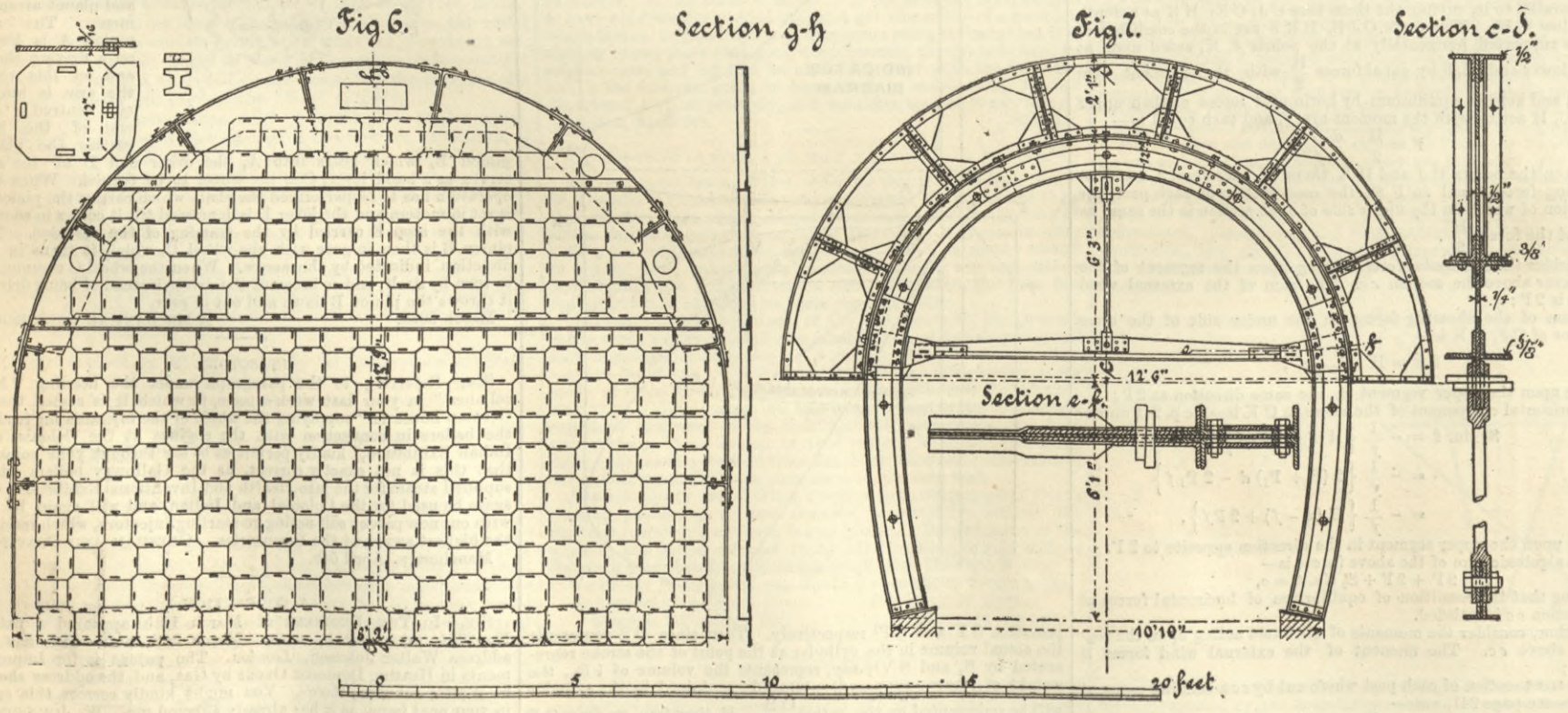
Fig. 6.

Section g-h

Fig. 7.

Section e-f.

Section c-d.



PUMPING ENGINES FOR BUENOS AYRES SEWAGE WORKS.

MESSRS. BROWNE AND BOBY, LONDON, ENGINEERS.

(*For description see page 282.*)

FIG. 1

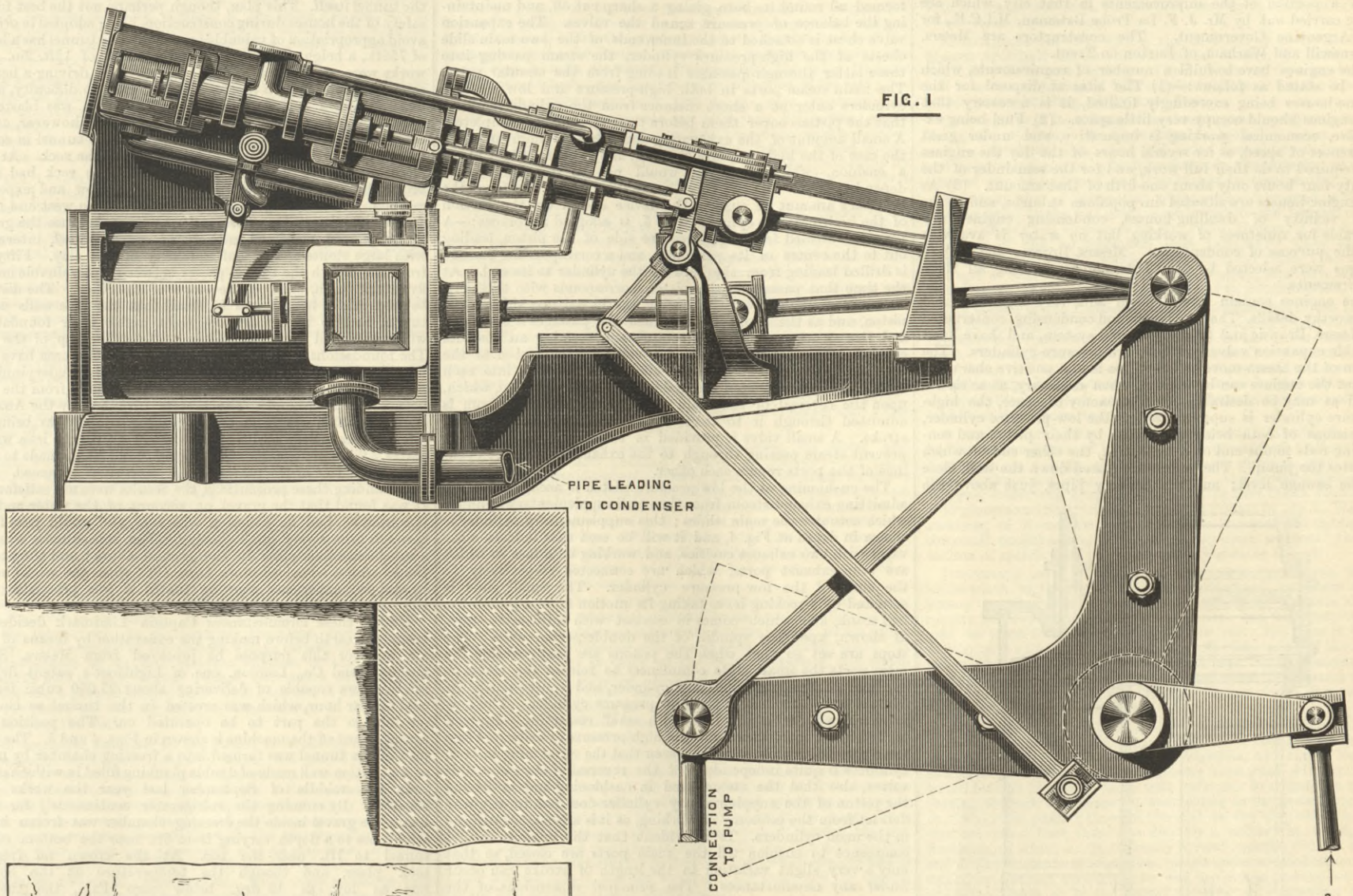


FIG. 2

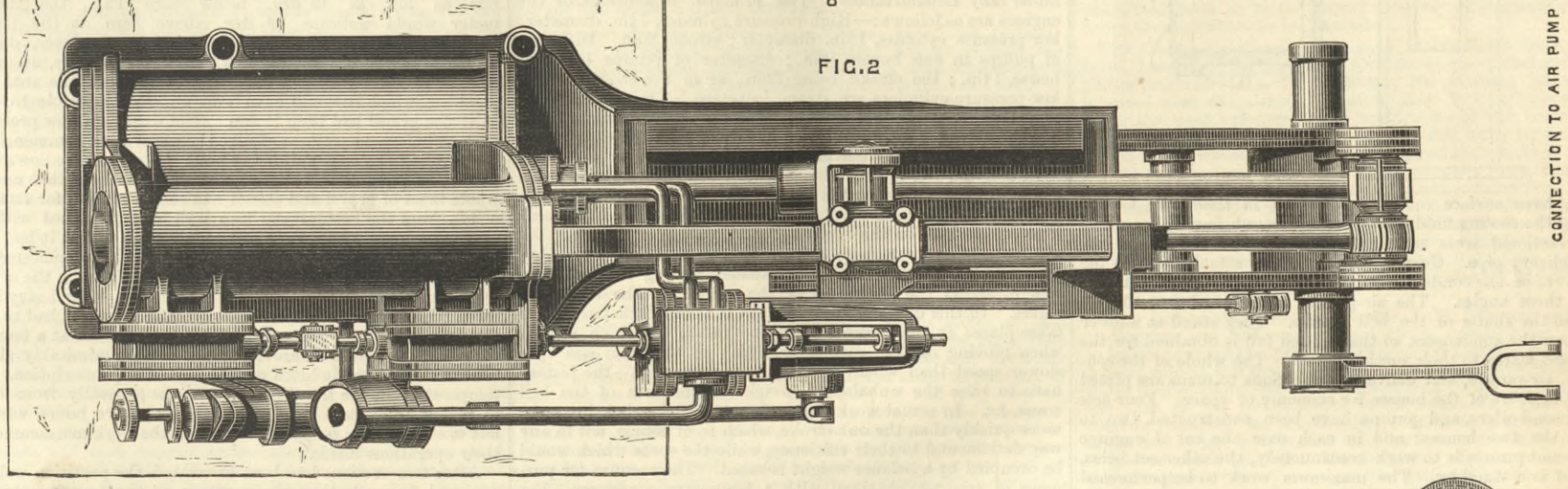


FIG. 3.

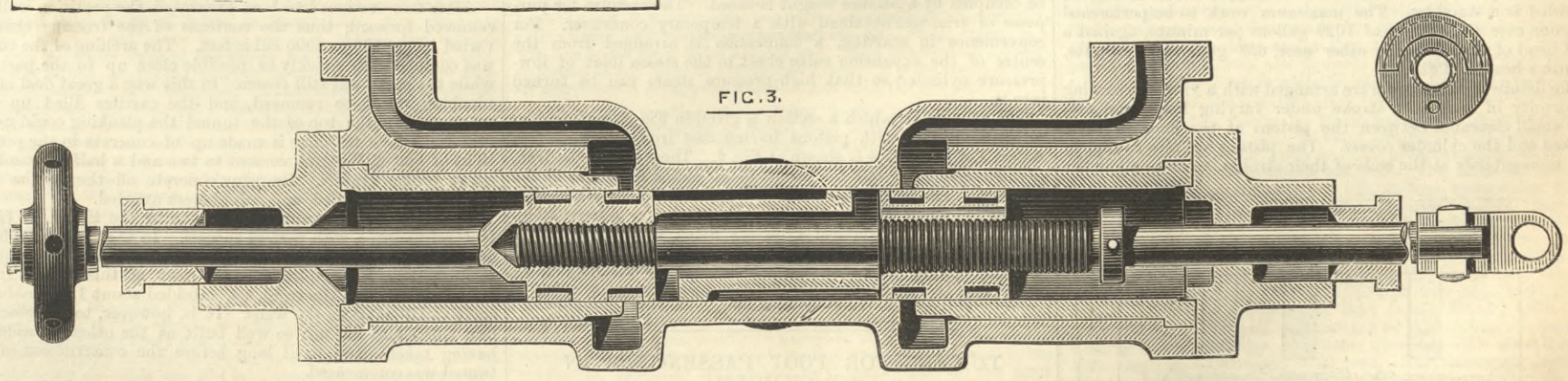


FIG. 5.

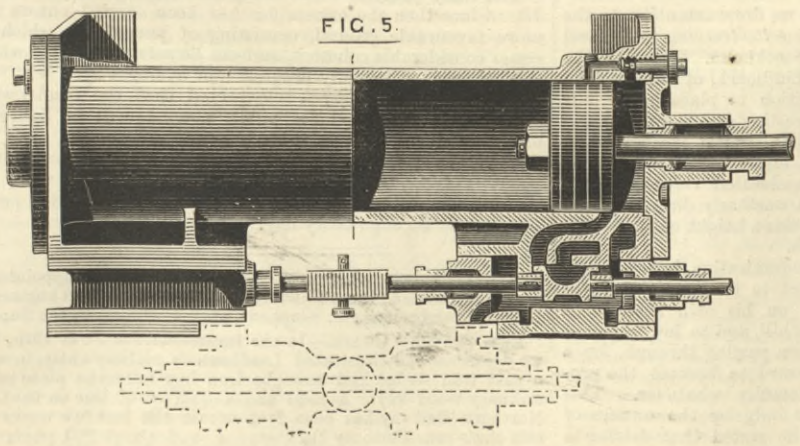
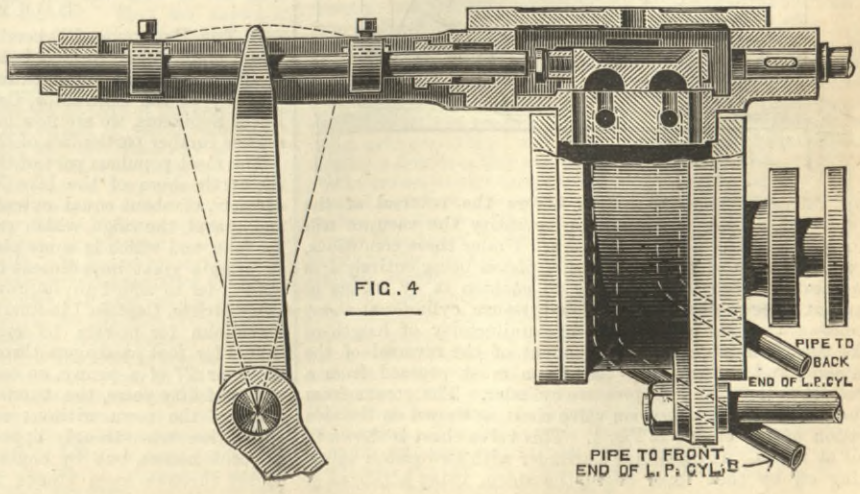


FIG. 4



BUENOS AYRES SEWAGE PUMPING ENGINES.

The pumping engines illustrated by the engravings on pages 281 and 284 have been made to the designs of Messrs. Browne and Boby, of 11, Queen Victoria-street, London, for pumping sewage in two of the outlying districts of Buenos Ayres, and form a portion of the improvements in that city which are being carried out by Mr. J. F. La Trobe Bateman, M.I.C.E., for the Argentine Government. The constructors are Messrs. Thornewill and Warham, of Burton-on-Trent.

The engines have to fulfil a number of requirements, which may be stated as follows:—(1) The sites at disposal for the engine-houses being exceedingly limited, it is necessary that the engines should occupy very little space. (2) Fuel being expersive, economical working is imperative, and under great differences of speed, as for several hours of the day the engines are required to do their full work, and for the remainder of the twenty-four hours only about one-fifth of that amount. (3) As the engine-houses are situated in populous suburbs, and in the close vicinity of dwelling-houses, condensing engines are desirable for quietness of working, but no water is available for the purpose of condensation. Messrs. Browne and Boby's designs were selected by Mr. Bateman as meeting all these requirements.

The engines contain several novel and very ingenious and noteworthy details. They are compound condensing, constructed on Messrs. Browne and Boby's patented system, and have hand variable expansion valves on the high-pressure cylinders. The action of the steam-moved slide-valves is of a positive character, so that the engines can be worked, when necessary, at as slow a speed as may be desirable. For economy of space, the high-pressure cylinder is superimposed on the low-pressure cylinder, the pistons of both being connected by their piston and connecting rods to one end of a bell crank, the other end of which actuates the pump. The pumps are placed down the well, close to the sewage level; and the delivery pipes, just above the

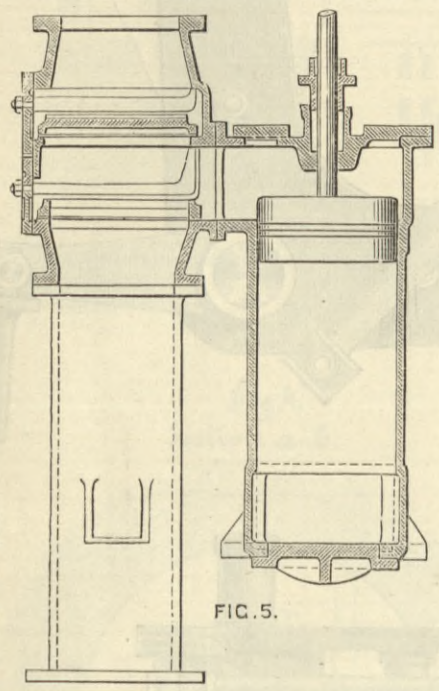


FIG. 5.

pumps, have surface condensers formed in them, the sewage forming the cooling fluid, and passing through four tubes whose united sectional areas are slightly in excess of the area of the main delivery pipe. Curved deflectors are attached inside the end covers of the condensers, to prevent undue friction in the flow at these angles. The air-pumps are worked from levers keyed to the shafts of the bell cranks. They stand at a lower level than the condensers, so that a good fall is obtained for the condensed water to their suction-valves. The whole of the condensers, air-pumps, and delivery connections to main are placed below the floors of the houses for economy of space. Four sets of engines, boilers, and pumps have been constructed, two to each of the two houses; and in each case one set of enginge boilers, and pumps is to work continuously, the other set beins, provided as a stand-by. The maximum work to be performed is in one case the raising of 1029 gallons per minute, against a total head of 26ft.; in the other case, 658 gallons per minute, against a head of 35ft.

The details of the engines are arranged with a view to securing uniformity of length of stroke under varying loads, and also very small clearance between the pistons at the ends of their strokes and the cylinder covers. The pistons are also caused to rest momentarily at the ends of their strokes, so as to allow the

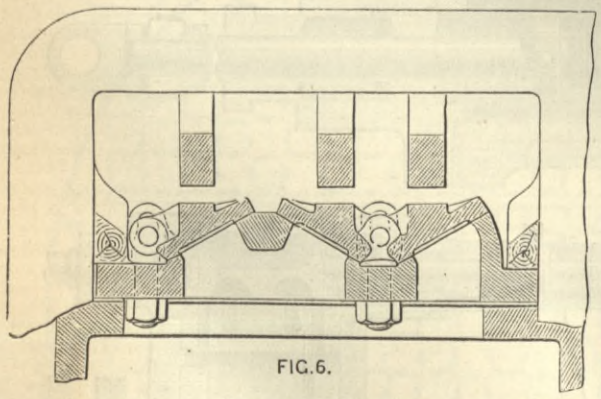


FIG. 6.

pump valves to seat themselves before the reversal of the current. In raising the minimum quantity the vacuum will perform the greater part of the work. Under these conditions, the exhaust side of the low-pressure piston being entirely free from steam, it becomes necessary to cushion it by means of steam introduced direct to the low-pressure cylinder at about the end of the stroke, and to ensure uniformity of length of stroke this cushion must be independent of the reversal of the main slide, and consequently the steam must proceed from a source other than the high-pressure cylinder. The steam from the boiler enters the expansion valve chest, as shown on the side elevation of the engine at Fig. 1. This valve chest is shown in detail at Fig. 3. It consists of a cylinder with two piston valves cutting off by their inner edges, the steam being admitted at the centre of the chest. The outer valve is forged in one piece with its rod, upon which is attached a hand wheel, and by turning this wheel both valves are revolved and the cut-off adjusted by means of the right and left-hand threads, as shown. The valves take their motion direct from a lever on the rocker shaft, seen in Fig. 1. The chest is constructed with a liner at each end, by means of which a very narrow annular port is formed all round its bore, giving a sharp cut off, and maintaining the balance of pressure round the valves. The expansion valve chest is attached to the inner ends of the two main slide chests of the high-pressure cylinder, the steam passing into these latter through passages leading from the annular ports. The main steam ports in both high-pressure and low-pressure cylinders enter at a short distance from the cylinder ends, so that the pistons cover them before their strokes are completed. A small amount of the exhausting steam is thus imprisoned in the case of the high-pressure cylinder, and to some extent forms a cushion, which, however, would not be sufficient to be depended upon with so short a cushion space. To form the necessary amount of cushion the device shown on the section of the high-pressure cylinder, Fig. 5, is adopted as follows:—A passage is drilled from the pressure side of the piston, leading out to the centre of its periphery, and a corresponding passage is drilled leading from the bore of the cylinder to its end. At the time that passage in the piston corresponds with this port, steam is admitted from the driving to the exhaust side of the piston, and as the stroke is continued the passages are shut off and the steam confined and compressed, forming an absolute cushion; the main steam port is covered by the piston at the moment that the two passages commence to open into each other. A small port from the main slide face is provided, which, upon the reversal of the main slide, is opened, and steam is admitted through it to start the piston slowly on its return stroke. A small valve is provided in the cushioning passage to prevent steam passing through to the exhaust side as the openings of the ports repass each other.

The cushioning of the low-pressure piston is accomplished by admitting exhaust steam from the small supplementary cylinder which actuates the main slides; this supplementary cylinder is shown in detail at Fig. 4, and it will be seen that it has a slide valve with two exhaust cavities, and working on a face in which are two exhaust ports, which are connected respectively to the ends of the low-pressure cylinder. The small slide is actuated by a rocking lever taking its motion from a pin on the bell crank, and which comes in contact with adjustable stops, as shown, upon the spindle of the double-ported slide. The stops are set so that when the pistons are just covering the main ports the small slide commences to release the steam in one end of the supplementary cylinder, and consequently its admission to the end of the low-pressure cylinder. The low-pressure cylinder is provided with small restarting ports controlled by its main slide as in the high-pressure cylinder. From the above description it will be seen that the cushioning in both cylinders is quite independent of the reversal of the main slide valves, also that the steam used in cushioning and in driving the piston of the supplementary cylinder does not in any way detract from the economy of working, as it is afterwards utilised in the main cylinders. It is evident that the engines cannot commence to cushion till the main ports are closed, so that only a very slight variation in the length of stroke can occur under any circumstances. The principal dimensions of the engines are as follows:—High-pressure cylinder, 7½in. diameter; low-pressure cylinder, 13in. diameter; stroke, 30in. Diameter of pumps in one house, 18in.; diameter of pumps in other house, 14in.; the stroke being 30in., as in the engines. The low-pressure cylinders are steam jacketted. The engines when tested under steam in this country were necessarily run light, and the indicator diagrams given on page 284 illustrate the action of the engines under these circumstances.

In diagram No. 1, page 284, it will be seen that a considerable amount of vacuum existed in the high-pressure cylinder—a condition very unfavourable for cushioning, and which could not occur if any load were on the engines; but even under these circumstances a good cushion is formed in the low-pressure cylinder. Diagram No. 2, taken with the exhaust passing to the atmosphere, shows the sharpness of the cut-off by the expansion valves. In this diagram it wil be seen that but little cushioning takes places at the "crank end," the reason of which is that when moving in that direction—which in this case was at a slower speed than when the vacuum was in action—the pistons have to raise the unbalanced weight of the arm of the bell crank, &c. In actual work the engines will make their in-stroke more quickly than the out-stroke, which is, of course, not in any way detrimental to their efficiency, while the space which would be occupied by a balance weight is saved. The vacuum for purposes of trial was obtained with a temporary condenser. For convenience in starting, a connection is arranged from the centre of the expansion valve chest to the steam inlet of low-pressure cylinder, so that high-pressure steam can be turned into it.

The pumps, of which a section is given in Fig. 5, are double-acting, and fitted with pistons having cast iron packing rings. A detail of the valves is shown at Fig. 6. These are of cast iron, of the hinged form, but free to lift as far at the hinged as at the free side. The seatings are wedged into the valve-boxes with wooden wedges. The foot valves are of similar construction. The boilers of the vertical type are fitted with Field tubes. Each boiler can be placed in communication with either engine, and the donkey pump on each boiler can be steamed from either, and also will feed into either, as may be desired.

TUNNEL FOR FOOT PASSENGERS IN STOCKHOLM.

In The Engineer of December 4th we drew attention to the recent employment of a cold air machine for freezing wet gravel in the construction of a tunnel at Stockholm. Through the courtesy of the contractor, Captain Lindmark, of the Swedish Royal Engineers, we are now in a position to place before our readers further particulars of this interesting and novel work.

The most populous part of the Swedish capital is situated on the north shore of the lake Mälaren, and is divided into two districts, of about equal extent, by an elevated ridge of stones and gravel, the ridge, which runs in a northerly direction from the lake, and which in some places attains a height of 70ft., constituting a great impediment to traffic.

In order to afford an improved communication between the two districts, Captain Lindmark applied to the municipality of Stockholm for powers to construct, on his own account, a tunnel for foot passengers through the hill, and to levy a toll of 2 öre, or ·27 of a penny, on each person passing through, for a period of fifty years, the tunnel afterward to become the property of the town without any indemnity whatever. This application was strongly opposed, not only by the owners of adjacent houses, but by engineers, who stated that driving a tunnel through loose stones and gravel, as proposed, would necessarily cause great subsidences in the ground, and consequent damage to the buildings above. The municipality, however, considering the great benefit that would result from the realisation of the project, granted the concession, and in the summer of 1884 the works commenced.

As shown by the engravings, Figs. 1, 2, and 3, on page 281, the tunnel follows the direction of a narrow street, scarcely wider than the tunnel itself. This plan, though perhaps not the best for the safety of the houses during construction, being adopted in order to avoid appropriation of valuable property. The tunnel has a length of 758ft., a height of 12ft. 8in., and a width of 13ft. 2in. The works were commenced from the east end by driving a heading at the bottom level—a matter which offered no difficulty, as the heading passed entirely through granite which was blasted by dynamite. The enlargement of the heading, however, caused considerable trouble, because the crown of the tunnel in several instances passed into fine sand lying close to the rock. At such places explosives could not be used, and the rock had to be broken by means of wedges, which was a slow and expensive method. The driving of the tunnel from the west end introduced difficulties of a more serious nature, because the ground to be pierced consisted entirely of coarse gravel, intermixed with large stones and a small quantity of wet clay. Fifty feet from the mouth the tunnel passes between two valuable houses, five stories high, built on the slope of the ridge. The distance between those houses was so small that the side walls of the tunnel had to be constructed right under their foundations, which extended down to within 10ft. of the top of the arch. The foundations of the houses could not in this case have been brought down to the bottom of the tunnel by underpinning—part'y on account of the great depth, but chiefly from the loose nature of the ground. The system invented by the Austrian engineer Rziha was from the beginning adopted as being the safest under such difficult conditions. Moreover, an iron wall of plates, 12in. square, as shown in Figs. 5, 6 and 7, was made to place against the face of the tunnel as the excavation advanced. Notwithstanding these precautions, the results were not satisfactory. It was found that the gravel, on account of the water and clay it contained, had no cohesion whatever, and would pass freely through even a very small opening. The consequence was that a subsidence took place in the ground above; and the excavations had not advanced more than 40ft. when the works had to be stopped, experience showing that if it was proceeded with the houses would in all probability come down.

Under these circumstances Captain Lindmark decided to freeze the earth before making the excavation by means of cold air, and for this purpose he procured from Messrs. Siebe, Gorman, and Co., London, one of Lightfoot's patent dry air refrigerators capable of delivering about 25,000 cubic feet of cold air per hour, which was erected in the tunnel as close as possible to the part to be operated on. The position and arrangement of the machine is shown in Figs. 4 and 5. The inner part of the tunnel was formed into a freezing chamber by means of a partition wall made of double planking filled in with charcoal.

In the middle of September last year the works were renewed. By running the refrigerator continuously for sixty hours the gravel inside the freezing chamber was frozen into a solid mass to a depth varying from 5ft. near the bottom of the tunnel to 1ft. near the top. At the crown no freezing took place, and though the temperature at the bottom was as low as 40 deg. below zero Fah., the thermometer would indicate 32 deg. above zero at the top, or 16ft. above the floor. This circumstance, however, did not occasion any inconvenience, but rather the reverse, as in any case it would have been necessary to support the roof with planking, which it would have been almost impossible to drive in if the gravel had been frozen. The work was now proceeded with as before, in sections of 5ft., the excavation commencing at the top, and the iron wall being built up from above downwards as fast as possible. But the great difference was that now the whole mass of gravel and stones was solid; indeed, for some 8ft. or 9ft. from the bottom the iron wall was dispensed with, the gravel forming such a hard and compact mass that it had to be cut away with special tools. After the first commencement it was sufficient to run the refrigerating machine on the average from ten to twelve hours every night, though after heavy rains, when much water percolated through the gravel, it had to work somewhat longer. The machine delivered the air at a temperature of 67 deg. below zero Fah., and worked admirably all the time without a single hitch or stoppage of any description. The temperature in the freezing chamber was generally from 6 deg. to 15 deg. below zero Fah., after ten or twelve hours' working, but it soon rose to freezing point when the workmen commenced their operations inside.

After two sections had been excavated the partition wall was removed forward, thus the contents of the freezing chamber varied from 3000 to 6000 cubic feet. The arching of the tunnel was completed as quickly as possible close up to the partition while the earth was still frozen. In this way a great deal of the planking could be removed, and the cavities filled up with masonry. In the top of the tunnel the planking could not be removed. The masonry is made up of concrete in the proportions of one of Portland cement to two and a half of sand and six of broken granite. By using concrete all the cavities were quickly and well filled, and subsidences avoided.

About 80ft. of the tunnel was driven by the aid of the Lightfoot refrigerator, with perfect success. In the residential house on the north neither subsidence nor cracks were perceptible two months after completion of the work at this point. In the house to the south the front has subsided about 1in., producing some small cracks in the walls. It is, however, to be observed that this house was not so well built as the other, subsidences having taken place in it long before the construction of the tunnel was commenced.

The daily progress while using the freezing method averaged 1ft. Since then the excavation has been carried out on much more favourable ground, consisting of pure sand, which possesses considerable cohesion, and can be safely cut away without being frozen. The daily progress now averages 2½ft.

In the middle of May it is expected that the tunnel will be completed and opened for public use. It will be lighted by means of Wenham's patent regenerative burners. The total cost of the undertaking, including all expenses, amounts to about £14,000, and to pay 10 per cent. on this sum, after clearing the working expenses it will require that 4400 persons should pass through every day.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—Alfred Wood, fleet engineer, to the Northumberland; J. Stephens, staff engineer, to the Superb.

Leadbeater's Chair.—In our impression for June 12th, 1885, we described and illustrated Leadbeater's railway chair, in which a cast iron wedge and wrought iron key take the place of the ordinary wood key. A mile and a quarter of line on the Great Northern Railway has been laid within the last few weeks with this chair near Finsbury Park station, and about 300 yards near Holloway station.

RAILWAY MATTERS.

IT is said that arrangements have been concluded for the commencement of the Hudson's Bay Railway, that 18,000 tons of rails have been ordered, and that the work of construction will be begun immediately.

A COMMITTEE consisting of General Hancock, Mr. Molesworth, and Mr. O'Callaghan, chief engineer of the Bolan Railway, are to decide whether the Sind-Pishin Railway will be carried through the Khwaja-Amran range by a tunnel or taken round by Nushki, a longer, but easier and cheaper route.

THE Minnesota Railroad Commission last autumn sought to reduce the rates on grain and other farm produce, and then selected those of the Manitoba road as being the lowest of the lines west of Minneapolis. Now it is announced that the commission proposes to reduce the rates, not of the railroads generally, but of the Manitoba alone, because it has made large profits.

AFTER twenty-seven years' service as the engineer of the M. S. and L. Railway, Mr. Charles Sacre has signified to the Board his desire to be relieved of the responsibilities he has so long undertaken, and his engagement will terminate at the close of the current half year. The directors, appreciating the value of Mr. Sacre's professional aid, have proposed to appoint him their consulting engineer on mechanical and other questions.

AN ordinary meeting of the shareholders of the Birmingham District Steam Tramway Company was held at Darlaston on the 31st ult., when the report of the directors set forth that application was being made to the Board of Trade for permission to abandon the projected lines from Wednesbury to Moxley, and from Great Bridge to Ocker Hill. The financial condition of the year was declared to be unsatisfactory.

A NEW company, named the Vernon Coal and Railway Company, has been registered at Brisbane, with an authorised capital of a quarter of a million. It is formed for constructing, maintaining, and working twenty-seven miles of railway from Urangan to Maryborough, building wharfs at the latter port, buying land in the vicinity of the railway, and purchasing 1000 acres of the Burrum coal reserve. The Bill authorising the formation of the company was passed in the session of 1884.

THE ceremony of the laying of the foundation stone of the Ely Viaduct of the Barry Dock Railway was performed on Tuesday morning by Mr. John Robinson, M.I.C.E., chief resident engineer, before a large assembly. The viaduct, which is to be part of the Barry Railway, will be 540ft. in length, and will include nine arches in all, each having a span of 45ft. The height is to be 78ft. from the river to the coping. It will be faced with Radyr stone, and the interior will be of mountain limestone, from the Alps Quarry. The erection of the viaduct will be carried out under the superintendence of Mr. Bell, resident engineer of the line, from the north end of the Wenvoe Tunnel, over which Mr. Robinson will exercise a general supervision. It is expected it will be virtually completed at the beginning of next winter if no accident should delay the work.

THE accidents reported to the Board of Trade by the railway companies in the United Kingdom during the year 1885 include accidents to trains, to rolling-stock, permanent way, &c., which caused the death of nineteen persons—six of them passengers and others, and thirteen servants of companies—and injury to 517—of whom eighty-one were servants, and 436 passengers and others. These figures compare favourably with the corresponding figures for 1884, when thirty-two passengers and twenty-three servants, or fifty-five persons in all, were killed, and 865 passengers and 115 servants, or 980 in all, were injured. Fifty-three collisions took place between passenger trains and goods or mineral trains, whereby five passengers and one servant were killed, and 133 passengers and thirty-one servants injured; so that to this class of injury, though less than 7 per cent. of the total number, is due nearly 32 per cent. of the deaths and the same percentage of the injuries.

THE Wilmington and Weldon Railroad Company, U.S.A., is making preparations to build an iron bridge across the Neuse river, near Goldsboro, N.C., in place of the wooden structure which has stood ever since the war. The bridge which is now to be replaced succeeded an old-fashioned wooden truss bridge, housed over, which was burned in December, 1862, during one of the sharpest of the minor actions of the war, the marks of which the writer carries about him until this day. In one sense the action was a drawn battle, as neither party ran away, but in another it was successful, for during its continuance the bridge was set on fire by a lieutenant of the Third New York Cavalry and two privates of the Ninth New Jersey Regiment, who managed to reach the bridge under cover of the railroad embankment, and succeeded in burning it, although it was covered by two Confederate batteries and a brigade of infantry, not 200 yards away. The three bridge burners escaped with their lives, although two of them were wounded, but the lapse of twenty-four years has unfortunately effaced their names from memory.

IF the following story in the New York *World* is correct, elephants will soon become an essential feature of a wrecking train:—"A fast freight on the Pennsylvania road ran into another freight six miles south of Bristol on March 13th. The elephants 'Chief' and 'Queen' were in the car just behind the locomotive, and the water tank of the engine slid into the forward compartment of the car, rolling everything in that part into the compartment which 'Chief' occupied. At the same time a heavy flat car slipped into the elephant's car from behind. 'Chief' braced himself against the confused mass of elephant and keeper, smashed wood, and water tank behind him, and received the flat car on his forehead, pushing against it with all his might. It was fully five minutes before 'Chief' could be persuaded that it was no longer necessary to hold the car up. Then, with wild trumpetings, he proceeded to demolish the flat car, but his keeper and the flames of the wrecked cars behind him compelled him to desist. Neither elephant was hurt much, and they tramped to Frankford, twelve miles. 'Chief' undoubtedly saved the life of his mate and their keeper."

SPEAKING of the cable tramway in Melbourne, the *Melbourne Age* says:—"The continual stoppages of traffic on the Melbourne section of the Richmond tramway line, due to the rope breaking, caused the tramway company to consider laying down another cable. It was thought when the cable was first laid, some four months since, that it would last six or eight months, but the wear and tear has been much greater than was anticipated, resulting in the wire strands constantly parting and interfering with the regular running of the cars. Mr. Casebolt, the engineer of the company, considers that the fractures in the cable, which is now replaced by a new one, were due to several causes. The chief reason assigned is the severe strain on the rope in passing round the curves over rough pulleys, and the excessive friction against the guide bars. This will be obviated now, as wider and larger horizontal pulleys have been fixed at the main curves at Spencer-street and Spring-street. The new cable was threaded after the last car had run one night, and the operation occupied about three hours. The immense coil of new cable, weighing between seventeen and eighteen tons, and measuring some five miles in length, was unwound off the large drum at the Fallsbridge, and coiled on a heavy boiler wagon. Early on Saturday, twenty-one horses were hitched to the wagon, and the heavy load was hauled out to the back of the engine house. A small portable engine was attached to a large winding drum, and in the course of ten hours the coil was rewound off the wagon ready for threading. When traffic had ceased for the night Mr. Casebolt had a gang of men ready to cut the old rope and splice on the new. The engine was set in motion and in due course the whole of the old cable on the Melbourne section was replaced by the new steel rope. The old rope, which had only been in use since 26th October, 1885, showed that the wire strands were parted every few inches.

NOTES AND MEMORANDA.

THE deaths registered during the week ending April 3rd in twenty-eight great towns of England and Wales corresponded to an annual rate of 22·2 per 1000 of their aggregate population, which is estimated at 9,093,817 persons in the middle of this year.

THE progress of drying up of the steppes around the Caspian Sea is steadily going on. *Nature* learns from a recent communication by M. Krasnoff to the Geographical Society, that the series of the Sarpinsk lakes in the Eastern part of the Kalmuck steppes, close to the Ergheni hills, are rapidly disappearing; the lakes Chilguir and Keke-tzun have quite disappeared in the course of the last year.

IN London, 2698 births and 1745 deaths were registered last week. The annual death rate per 1000 from all causes, which had been 30·3 and 26·9 in the two preceding weeks, further declined last week to 21·9. During the thirteen weeks ending last Saturday the death rate averaged 24·8, and exceeded by 0·8 the mean rate in the corresponding periods of the ten years 1876-85.

GENERAL TILLO publishes in the last issue of the *Izvestia* of the Russian Geographical Society, the results of new exact levellings made in order to ascertain the heights above the sea of Lakes Ladoga, Onega, and Ilmen. Their respective heights above the average level of the Gulf of Finland appear to be only 16ft., 115ft., and 59ft., with a probable error not exceeding 1·5ft. *Nature* says the formerly accepted heights were 59ft., 237ft., and 157ft.

A PAPER on "Sight Feed Lubricators," in the *Journal of the British Society of Mining Students*, recently published, gives the results of experiments which in one case, with a 36in. winding engine, showed a saving as between 24 quarts of oil per week and 4·5 quarts, representing a saving in oil of 17s. 6d. per week, beside which would be the economy resulting from continuous lubrication. The same journal contains a useful paper on "Board and Pillar Workings," by R. A. S. Redmayne.

PAPER is rendered suitable for wrapping up silver and delicate metallic and polished articles as follows:—Six parts of caustic soda are dissolved in water until the hydrometer shows 20 deg. B. To this solution are added four parts of oxide of zinc and boiled until dissolved. Sufficient water must next be added to reduce the solution to 10 deg. B. Next dip paper or calico into this solution and dry. This wrapping, the *Scientific American* says, will very effectually preserve silver articles from being blackened by sulphuretted hydrogen, which, as is well known is contained in the atmosphere of all large cities.

GUTTA-PERCHA from *Bassia*, or *Butyrospermum Parkii* (*Comp. Rend.*, 100, 1239) resembles ordinary gutta-percha in its physical properties. It is obtained in compact, fibrous masses, which soften in warm water and become adhesive at about the boiling point. It becomes electrified as easily as the ordinary variety, and serves equally well as an insulator; sp. gr. 0·976. The gutta-percha from Bassia is, however, much less soluble in light petroleum, terebenthene, ether, and boiling acetic acid than the ordinary variety, but is almost equally soluble in carbon bisulphide, chloroform, benzene, and boiling alcohol of 95 deg.

AN improvement in the driving of grinding stones and emery wheels is that by which the wheel is given a reciprocating motion in addition to its rotation. Every one has noticed the advantage of moving a tool from side to side on a hand grindstone, so as to equalise the attrition on the different parts of the edge. It is found that by making the grindstone move, and keeping the tool still, a more perfect result is attained, while the detached particles of steel have an opportunity to drop off the grindstone, instead of being crushed into it, and the wearing of the stone and the heating of the tool are both greatly diminished.

ACCORDING to M. L'Hôte (*Comp. Rend.*, 101, 1153) perfectly pure zinc, obtained by mixing precipitated zinc oxide with calcined lamp-black and distilling the mixture, does not decompose water at 100 deg., and is not attacked by dilute sulphuric acid. If the pure zinc is melted in a crucible and stirred with an iron rod, it takes up 0·03—0·05 per cent. of the iron, and the impure zinc thus obtained decomposes boiling water and dissolves in dilute sulphuric acid. The presence of very small quantities of antimony or arsenic have the same effect on the properties of zinc. All commercial samples of the metal decompose water at 100 deg. The *Journal of the Chemical Society* says the author recommends the use of zinc containing a small quantity af iron in Marsh's process in order to insure a regular evolution of gas.

"THE Geology of the Pittsburgh Coal Region" is the title of an interesting paper, recently published, by Professor Lesley. The amount of coal in the Pittsburgh region is estimated at about thirty billion tons—an amount practically inexhaustible, at least for centuries. During 1884, eleven million tons were taken from the Pittsburgh bed—an output of about 60 per cent. of the whole bituminous coal-production of the State, and about 33 per cent. of the shipments of anthracite. Concerning oil and gas, however, the author has very different views. He says, "I take the opportunity to express my opinion in the strongest terms, that the amazing exhibition of oil and gas which has characterised the last twenty years, and will probably characterise the next ten or twenty years, is nevertheless, not only geologically but historically, a temporary and vanishing phenomenon—one which young men will live to see come to its natural end. And this opinion I do not entertain in any loose or unreasonable form; it is the result of both an active and a thoughtful acquaintance with the subject."

AT a recent meeting of the Royal Society a paper was read—"On the Magnetisation of Steel, Cast Iron, and Soft Iron," by Mr. John W. Gemmell. The author described, and gave the result of, a series of experiments upon particular specimens of iron and of steel. The specimens consisted of wires of soft Scotch iron, common wire, charcoal iron, and soft steel, with bars of cast iron and malleable iron; and the object of the investigation was to find the difference between these, with respect to the intensities of their total and residual magnetisation, due to different degrees of magnetising force. The apparatus was arranged, and the experiments made, according to a simple magnetometric method fully detailed in the paper. The magnetising currents were derived from a battery of Thomson's tray Daniells, so arranged that any number of cells could readily be placed in the circuit. The results represent the effect of a current gradually increased from 0 to the maximum, gradually diminished to 0 again, and of the same process repeated with a negative current. They are shown in curves, the abscissæ of which are proportional to the magnetising forces, and the ordinates to the magnetisation produced. Figures are given by which to reduce these values to absolute measure. It has been found that the charcoal iron has the highest magnetisability, and the soft steel the lowest; while that of the soft Scotch iron approaches the former. With regard to retentiveness, the charcoal iron shows the least, and the soft steel the greatest. Annealing the latter, however, has the effect of bringing it very near the common wire, both in respect of magnetisability and retentiveness. The two specimens of cast iron differ considerably. The malleable iron bar shows a very much higher magnetisability than the cast iron ones, and its residual magnetisation was so low that it could not be observed with the same arrangement of apparatus. These curves also present certain anomalies which are worth investigation. The space about the zero on an enlarged scale is affixed to each set to show its peculiarities more clearly. In the curves representing the residual magnetisation we find a loop between the direct and return curves, more or less marked in all the diagrams. A similar feature presents itself in the curves of total magnetisation in two of the diagrams, and there seems to be a tendency always to form this loop. In that part of the return curve which represents the effects of the small magnetising forces, the residual magnetism is seen first to take a greater value, and then to diminish again just before the zero of magnetising force is reached. This may be observed also in the negative return curve.

MISCELLANEA.

THE Council of the Société Internationale des Electriciens of Paris have appointed Mr. R. Aylmer, M.I.C.E., A.S.T.E., as the society's hon. secretary and treasurer for England.

THE Russian Minister of Marine has announced his intention of giving a series of prizes, commencing with one of £100 and ending with several of £25 each, for the best essay on the defence of men-of-war from torpedo boats.

A LARGE one-ton lift, with a rise of 70ft., is to be made by Messrs. Archibald Smith and Stevens for Messrs. W. Briscoe and Son's new warehouse, Sydney. It will be driven by a gas engine, and is to be a duplicate of lifts supplied last year for the Hon. B. Rundle's new building, of the same town.

CAPITALISTS of Copenhagen are about organising a Russo-Danish Navigation Society. It is to have a capital of seven million roubles—5,560,800 dols.—and will order from thirty to forty iron and steel steamers, to be built probably in Copenhagen, which in times of war can be armed, and then be used for transporting troops.

A COLLECTION of interesting photographs connected with the Southampton Docks has been contributed to the library of the Institution of Civil Engineers by Mr. Philip Hedger, A.I.C.E., the secretary of the Southampton Dock Company. They show a large number of vessels which have been under repair after heavy damages as well as under other circumstances, and have all been taken by Mr. W. R. Scanlan, of High-street, Southampton.

THE launch of the Russian ironclad, Tchesma, one of the 11,000-horse power engines of which was shown running round slowly at the Antwerp Exhibition of last year, is fixed for the middle of April. Baron Sadoine, the general manager of the Cockerill Company, is invited to be present at the launch, when it is hoped that he will terminate negotiations, bringing work enough to last the Cockerill Works and all the others in the neighbourhood of Liége for two or three years to come.

A USEFUL chart of the coast from Tynemouth to Newbiggin, showing the measured knot at Hartley and the course from Cullercoats to Newbiggin on a large scale, and a small diagram map of the measured knot, are being published by Mr. Andrew Reid, Newcastle-on-Tyne, under the auspices of the North-East Coast Institution of Engineers and Shipbuilders from maps revised by Mr. E. Watson, surveyor, of Newcastle. A speed table is printed at the back of the small pocket chart, and would be of much service if the first column of speeds were not wrong from beginning to end.

DESPERATE cases sometimes need desperate measures, but it seems much to the discredit of those concerned, to whom much honour is otherwise due, that the matters at Panama should require the expenditure of so much labour and ingenuity to prevent the truth from reaching the public ear. Evidence of trustworthy men and the logic of actual events make many of the statements concerning the work at the canal look like statements very much indeed in advance of the facts, and show the Panama Canal work to be in a bad way, and that, if ever completed, it must cost many times the estimated cost.

AT the meeting of the Manchester Geological Society held on Tuesday, Professor Williamson referred to a book he has in preparation dealing with the subject of stigmalia, and stated that he should be glad if any mining engineers connected with collieries would furnish him with facts with reference to stigmalian plants passing through coal measures and rooting in the underlying clay, or of the roots passing through the coal to the clay beneath. He was convinced that there was scarcely a colliery in which such instances, of which he had already several records, did not occur; and as the existence of stigmalian plants under such conditions was denied by German geologists, he was anxious to be supplied with undoubted facts as to the actual discovery of stigmalian plants under the conditions he had described.

THE Electro-Metallurgical Company, of Charlotte-street, Blackfriars, London, S.E., has taken over the electro-nickel and silver-plating business from its neighbour, Mr. William Elmore. It is stated that the electro-depositing plant in Charlotte-street is by far the most extensive in the world, some of the tanks having ample capacity to admit of a horse and cart being turned round within them, whilst their depth is 15ft., and such tanks to be used for the electro-deposition of the various metals must necessarily have the most powerful dynamo machines obtainable. We are informed that William Elmore and Co. have discontinued their plating department in order to confine their attention to dynamo machinery and outfits for depositing silver, nickel, &c., and for metal refining and extraction of metals from their ores, the recently perfected machines being each capable of depositing 20 tons of metal per week.

IT is just being pointed out by Mr. J. W. Sparrow, one of our leading iron and coal masters, and who is agitating for a return to longer hours at the pits, that Belgian bar iron and nail rod iron is being sold at this moment at £4 a ton free on board at Antwerp, while Staffordshire bar and nail rod iron cannot be produced at less than £6 per ton delivered in the Thames. "Here is," Mr. Sparrow remarks, "an article which consists 90 per cent. of it in labour and 10 per cent. in rent and royalty, our cost is 50 per cent. or half as much more than the Belgian." The same ironmaster also points out that the seat of the galvanised iron trade is in Wolverhampton, and that one of the principal manufacturers and exporters of such iron states that his consumption of nails in packing cases is 10 cwt. and upwards per week, and that he does not use a single English nail, all of them are of foreign manufacture made on the Continent and consumed in Staffordshire.

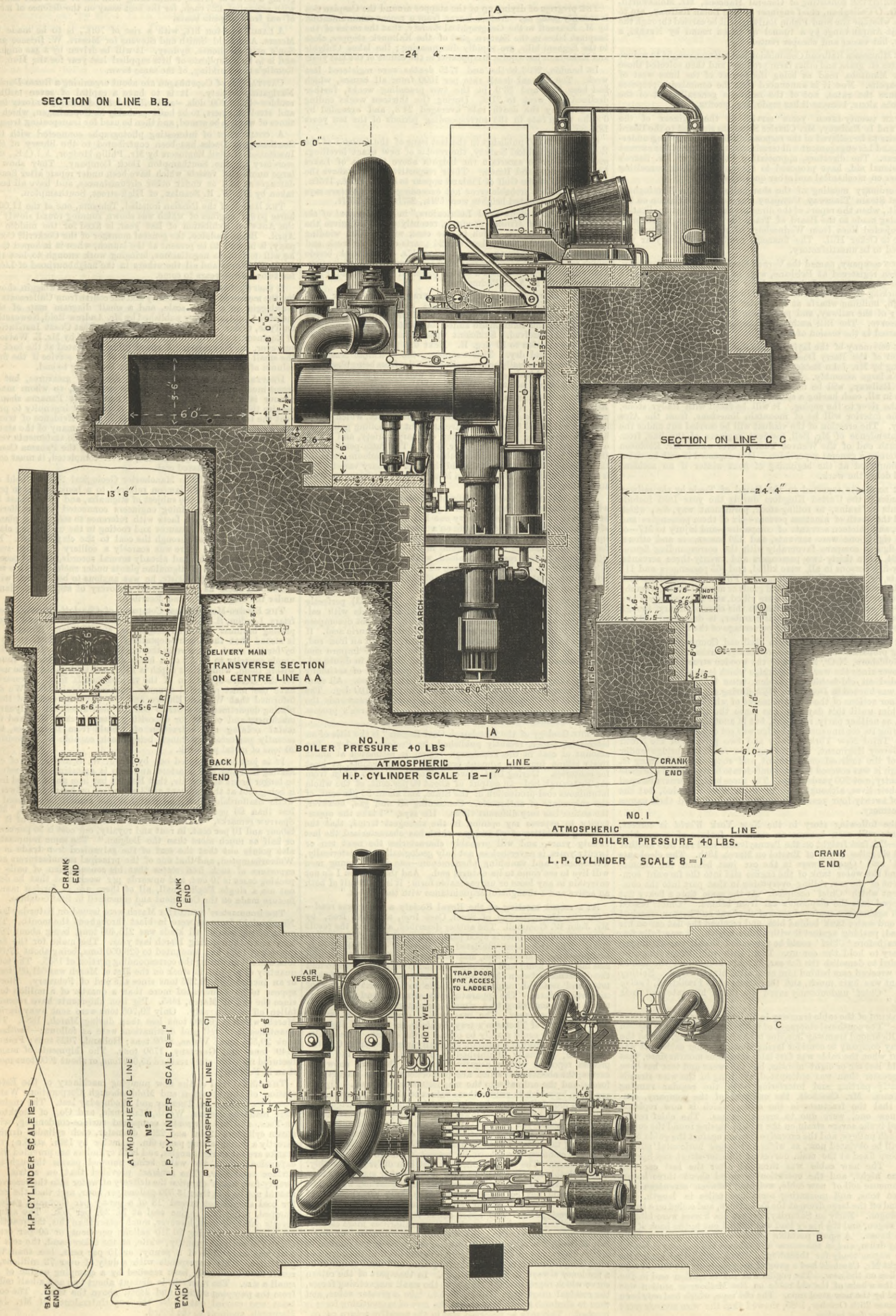
THE ironmasters' returns for March were issued on Saturday last. Ninety-eight furnaces were in blast throughout the month. The make of pig iron of all kinds was 215,405 tons, being about 7000 tons more than during March last year. The make for the first quarter of 1886 has amounted to 628,050 tons, being about 37,000 tons more than during the corresponding portion of 1885. The total quantity of pig iron in stock on the 31st of March was 641,621 tons, or an increase of 29,296 tons since the end of February. Stocks appear to have increased more than a quarter of a million tons since the end of March, 1885. Pig iron shipments have recently fallen off considerably. Only 59,705 tons were sent away during March, which is 10,000 tons less than during March, 1885. The quantities in detail and destinations were as follows:—Scotland took 29,535 tons; Wales, 8808 tons; Holland, 7625 tons; France, 3149 tons; and Germany, 1750 tons. The shipments of manufactured iron and steel reached 35,609 tons, or about 4000 tons more than in February.

THE official trial of the new pumping machinery of the Eston station of the Stockton and Middlesbrough Corporations Water Board took place on Tuesday and Wednesday last. The engines were made by Messrs. Worth, Mackenzie, and Co., of Stockton-on-Tees, and are horizontal compound surface-condensing, with steam cylinders 12½in. and 22in. diameter, each cylinder driving directly a double-acting pump 6in. diameter by 18in. stroke; the cranks are set at right angles, and both cylinders are provided with expansion valves, the water being pumped passes through the surface condenser. The contract provided that on a trial of twenty-four hours' duration the delivery of water into the reservoir should not be less than 13,500 gallons per hour, and that the cost for coal should not exceed ·18 of a penny per thousand gallons pumped, using fair engine coal at 7s. 3d. per ton. The actual results obtained were, however, much better than this, the quantity actually pumped being 20,310 gallons per hour, or 50 per cent. above the contract quantity, while, on the other hand, the cost of coal was only ·153 of a penny, or 15 per cent. less than the guarantee. This corresponds with a duty of over 72 millions, a result that has rarely been reached by a pumping engine of so small a size. The reservoir is distant about two and a-half miles from the pumping station, and 245ft. above the same. The contract was carried out under the superintendence of Mr. Jas. Mansergh, engineer to the board.

PUMPING ENGINES FOR BUENOS AYRES SEWAGE WORKS.

MESSRS. BROWNE AND BOBY, LONDON, ENGINEERS.

(*For description see page* 282.)



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PARIS.—Madame Boyveau, *Rue de la Banque.*
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NEW YORK.—The Willmer and Rogers News Company, 31, *Beekman-street.*

CONTENTS.

TO CORRESPONDENTS.

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

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*** *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.*

T. J. (Gloucester-road).—*There are about sixteen recognised rules. Which of them would you prefer?*

T. and C. (Metropolitan-buildings).—*We cannot illustrate inventions which are not actually in use. When yours has been adopted on some leading railway we may refer to it fully.*

A. D.—*For the blue tracing process see* The Engineer, *19th April*, 1878, *and 26th April*, 1878. *Paper ready prepared for this purpose may be obtained of several London firms.*

SEA SALT CRUSHING MACHINE.

(*To the Editor of The Engineer.*)

Sir,—Can any of your readers give me the name of a maker of sea salt crushing machines, to reduce to a medium size for sardine packing?

J. R.

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

MEETINGS NEXT WEEK.

The Institution of Civil Engineers, 25, Great George-street, Westminster, S.W.—Friday, April 9th, at 7.30 p.m.: Students' meeting. Paper to be read, "Locomotive Engine and Carriage Sheds, as used on the Caledonian Railway," by Mr. Gilbert M. Hunter, Stud. Inst. C.E. Mr. J. Wolfe Barry, Member of Council, in the chair. Tuesday, April 13th, at 8 p.m.: Ordinary meeting. Paper to be further discussed, "Water Purification: its Biological and Chemical Basis," by Mr. Percy F. Frankland, Ph.D., B.Sc., F.C.S. Paper to be read, time permitting, "Brick-making," by Mr. Henry Ward, Assoc. M. Inst. C.E.

Parkes Museum of Hygiene, 74A, Margaret-street, Regent-street, W.—Thursday, April 15th, at 8 p.m.: Lecture by the Rev. F. Lawrence "On Eremacausis: Sanitary Burials."

Chemical Society.—Thursday, April 15th, at 8 p.m.: Ballot for the election of Fellows.

Society of Arts, John-street, Adelphi, London, W.C.—Monday, April 12th, at 8 p.m.: Cantor Lectures. "The Arts of Tapestry-making and Embroidery," by Mr. Alan S. Cole. Lecture II.—Method of making tapestries compared with that of simple weaving and carpet-making. Textiles of Græco-Egyptian, Turcoman, modern Japanese. Application of the tapestry-making process to hangings. Antiquity of use of hangings. Bayeaux tapestry. Tapestry from St. Gereon, at Cologne. Scheme of its pattern compared with that shown in Sassanian metal-work. Sicilian weavings. Italian and Icelandic embroideries. Influence of Flemish paintings upon designs in 14th and 15th centuries. Spread of tapestry-making in other European countries. Tuesday, April 13th, at 8 p.m.: Foreign and Colonial Section. "Progress of the British Possessions in the Last Quarter of a Century," by Mr. P. L. Simmonds. Wednesday, April 14th, at 8 p.m.: Nineteenth ordinary meeting. "The Treatment of Sewage," by Dr. C. Meymott Tidy. Sir Frederick Abel, C.B., D.C.L., F.R.S., Chairman of the Council, will preside.

DEATH.

On the 4th inst., at his residence, 22, Harewood-square, N.W., Sidenham Duer, C.E., B.Sc., in the 51st year of his age. French, Chinese, and Japanese papers, please copy.

THE ENGINEER.

APRIL 9, 1886.

THE INSTITUTION OF CIVIL ENGINEERS.

Twenty years ago the premises of the Institution of Civil Engineers at 25, Great George-street, Westminster, had been found inadequate to its requirements. The list of its members then included less than 1300 of all classes. They number now about 5000, and still the same building is the home of the Institution, although it has not only grown thus enormously in numbers and in wealth, but it has grown equally in influence, until indeed it has become the greatest engineering society in the world. In January, 1866, when Mr. (now Sir) John Fowler delivered his presidential address, the inadequacy of the building; insufficient size of the meeting hall; and inconvenience of the rooms generally, formed the subject of his special notice, and he expected that the society would at an early date consider a distinct proposal for a new building worthy of the position of the Institution. The proposal when made was rejected, and two years later a sum of £17,000 was spent on a compromise which merely handed the matter on for early future consideration and expenditure. Since then the question has from time to time received consideration, and each time been shelved, and the Institution is at this day quartered in the building which it entered in 1838, when there were only 351 members of all classes, including graduates, or not one-fourteenth of the present number, nor so many as is now often present at each weekly meeting. The only increase in the accommodation ever made was obtained in 1868 by taking the back half of the next house, a compromise which secured enough room for the immediate requirements of the Institution, but which, like all compromises in such matters, has simply been an addition to the ultimate expenditure, and has involved continual make-shift arrangements necessary in the conduct of the business of the Institution. The seats in the meeting hall or theatre have had to be rearranged and placed as close together as those in an old London theatre pit, and even then it is often so crowded as to cause great inconvenience. The library has long been crowded and very inconvenient, and large numbers of books and papers are stowed away out of sight. The reading-room has to be cleared out to provide room for the members and visitors before and after the meetings; the Council room has to be cleared in the same way; and half the secretary's office can only be reached by crushing past the barricade of hats and coats which crowd out everything from the other part. The Institution possesses no room for the reception and display of models, or of objects of interest, though it might possess an almost unlimited quantity of great importance and value, both from the instructive and historic point of view; and it possesses no room or rooms which might be of convenience to members who, on frequent occasions and after meetings, do not require the reading-room, but need some social accommodation, though not of the character of a club. For forty-eight years has the Institution been located in the house which even when a small body it required, and at the end of that long period of continuous growth and influence it squeezes itself into the same house, and begs round London for a room when it wants to eat its annual dinner. It has grown into affluence, but to this day it makes the presentment to the world that it did when it could only just pay the expenses of existence nearly half a century ago. It now represents one of the wealthiest, most powerful, and most honoured of professions; its leading members are honoured for their achievements, and not for mere wealth; and yet it grumbles to-day, as it did in 1866, that it wants accommodation, wants room, and some few have even dared to step outside the simple demand for absolute necessities, and have expressed the opinion that an ordinary street dwelling-house of the year 1838 presents a less dignified appearance to the world than might be desired even by a society of engineers. Engineers may not be in the habit of expending money on æsthetic or even architectural finish of their structures, but if the home of the Institution is to be supposed to have any influence, there is little need of surprise that engineers so seldom either propose or urge anything upon their clients which is not strictly of the utilitarian order. English people are ever forced to admit the superior appearance of public works built from the designs of engineers on the Continent, as compared with those at home. But it would appear that English engineers care so little for fitness from an architectural point of view, that their professional home makes no pretence to structural or architectural qualification in its owners. In 1868, when the back addition was made to the room accommodation, it was done against the wishes of Mr. McClean, Mr. Fowler, and many more who wanted to construct an entirely new and suitable building on the opposite side of Great George-street and forming one side of St. Stephen's-square. At that time the Institution was not in a position to pay down in cash a large sum for a palatial building; but it need not have put the whole of the money down for the purpose any more than it need now, though it can do so. It has become now no matter of fancy, but a matter of absolute necessity, and the Council of the Institution can hardly be said to do its duty if it does not provide a proper and creditable home, and accommodation suitable for and in every way sufficient and worthy of a body which has members all over the country and the world, and which claims to represent English engineering.

THE RAILWAY RATES BILL.

We feel no surprise that the railway companies have sounded a note of alarm. The Railway Rates Bill is very well calculated to excite the apprehensions of directors and shareholders. The contention of the companies is that the State has no right to fix the rates which railway companies shall charge for the conveyance of goods over their lines. On the face of Mr. Mundella's Bill as it stands, the railway companies may be compelled to carry goods, not at the prices which will pay the companies, but at those which a board or commission may hold to be proper. It is, urge the companies, an extension to railways of the principle of the last Irish Land Act. That fixes the rents to be paid to landowners, not by the ordinary laws of supply and demand, but by the will of a legal tribunal. They assert that the money invested in railways has been spent on the understanding that the investors were to be permitted to charge certain rates, and that as a matter of fact they have not exerted their full powers in this respect, all rates being really lower than those which their respective Acts of Parliament permit them to charge. The case they can make out is, from one point of view, ostensibly good; but when we have said this much we have conceded all we are disposed to concede. Railway directors apparently forget that their Acts of Parliament give them very valuable privileges, and that there is this wide difference between them and Irish landlords, that they are the servants of the public, and the landlords are not. Railway companies carry on their operations under conditions very different from those of private companies. They possess monopolies conceded to them by the State, and, as a result, the State possesses, within limits, a power of interference. All property has its duties as well as its rights, and the railways owe a duty to the State which finds no parallel in private enterprises. Therefore any protest made by the companies against State interference with their proceedings must be looked on with a certain amount of hesitation.

To put the question in an extreme light, let us suppose that any great railway company, in the exercise of its own wisdom, determined to augment its rates for the carriage of minerals and merchandise to an extreme degree. The result would, of course, be a paralysis of manufacturing industry throughout the district served by the railway. But the condition on which the company obtained its Act was that it would serve the district in question. It was for the good of the community, not for that of the shareholders, that great powers—such as those of compulsory purchase of land—were conferred on it by Parliament; and Parliament would certainly not do its duty by the community at large if it did not, under such circumstances, interfere. It may be argued with perfect truth that any railway company pursuing so suicidal a policy would kill the goose which laid golden eggs. But without going so far as this, it is quite possible for a company to injure one district while serving another. Not only may it be admitted that this is possible, but it is the contention of traders generally that it is actually done daily, preferential charges operating most injuriously on various districts, and it is noteworthy that many partisans of the railway companies admit freely that a readjustment of tariffs is needed. There can be no doubt but that when competition comes into play, and a given town is served by more railways than one, charges are less than when a given railway has things all its own way—when, that is to say, the given town or district must be served by one railway or not at all. There are two special points urged by the traders. The first is that certain districts are oppressed and others favoured by the railway companies; and the second is that all railway rates of every kind are too high. These two propositions ought to be kept distinct; they demand different modes of treatment. Concerning the first, let it be assumed that for the traffic of a given town competition exists. It is served by more lines than one, and as a result the companies convey goods for a stated distance of, say, 100 miles at 5s. per ton. Following the lines, we find that they diverge, so that on both of them centres of industry exist which are each served by only one line. The charge for carrying goods to and from these is 10s. per 100 miles per ton. Now it may be safely assumed that if goods can be conveyed under the first set of conditions for 5s. per ton, they can also be carried under the second set of conditions for the same sum; and it is not wonderful that the traders in the over-rated districts should maintain that they are treated unjustly. We do not, however, assert that because a company chooses to carry in one district at one rate, that it must of necessity be compelled to carry in another district at the same rate. It may think fit to carry at a loss to injure a rival. But we do maintain that there is a very strong *a priori* case against the company under the circumstances.

As regards the second point urged—namely, that railway companies all charge too much for the conveyance of goods—a great deal may be said on both sides; but it is certain that there is every reason to believe that these charges are often not only too high, but so much too high that very grave injury is done to the commerce of this country. Some time ago we showed that the actual cost of conveying a ton of coal from the Midland counties to London, after every expense had been allowed, was about one-third of the sum actually charged by the companies. This statement obtained very wide circulation, and no attempt was ever made to contradict the accuracy of our figures. If it can be shown that a railway company is making an enormous profit on the carriage of any one class of goods, then those dealing in such goods have a right to demand an explanation. Railway companies allege that the dividends they pay are small; but this, as regards our principal lines, is hardly the fact. It is very difficult to find any first-class security—such, let us say, as the London and North-Western Railway—paying six per cent. per annum. It is quite true that those who have to buy shares now cannot get anything like this; but the circumstance does not affect the

general statement. We shall not be far wrong if we take the working expenses of English railways at 50 per cent. of the gross receipts. Where shall we search for any other commercial undertakings of which the same may be said? Furthermore, it must not be forgotten that there is no reason to assume that railways are now worked with maximum economy. It is, indeed, more than probable that, under a sufficient stimulus, considerable reductions might be made without in any way cutting down efficiency. Again, it may be argued with much force and cogency that railway directors, by charging rates which are too high and unequal, are injuring their own interests. In every instance where tariffs have been reduced, the companies have reaped an advantage. Take, for example, third-class traffic. It was looked on as a nuisance until Mr. Allport, of the Midland, showed that it might be made the mainstay of a company; and it is a fact that the third-class traffic not only now pays for itself, but for the first and second-class traffic as well. The great companies might have contended until recently that a reduction of rates would only have resulted in glutting their lines with more traffic than they could handle; but the doubling of lines, not only near London but far out into the country, has got over this difficulty, and there are very few roads in existence which could not handle more traffic than they now get with ease and certainty.

The weakest feature in the existing opposition to Mr. Mundella's Bill is the assumption that the act of any tribunal appointed to revise railway tariffs must be unjust and arbitrary. We believe that such an idea is entirely unwarranted and unwarrantable. It has long been felt that traders had at least a strong case against the railway companies. These last have never been conciliating; they have stood on their rights, or their fancied rights, and now they shrink and shiver with fear of an impending storm. If we imagined that the acts of a railway commission were likely to be unjust, we should be among the first to lift up our voices in defence of the companies; but we hold that there is a strong case for inquiry and investigation, and that the operations of a just tribunal cannot fail to be beneficial to the community of traders, and, in the long run, to the companies themselves. Railway directors are not men of superhuman wisdom, and they are, we fully believe, very often quite in the dark as to the best modes of promoting the interests of the companies they represent. If they are perfectly fair and honest in their dealings, if they are really doing their best for the public, they are doing the best for Great Britain; and they have nothing to fear from an inquiry which may or may not result in a revision of tariffs. If on the contrary, they are, and have been, pursuing a short-sighted grasping policy, then they may well feel alarm. They may need to be taught what is good for themselves. The prosperity of the nation is dependent to an almost incredible extent on the policy pursued by railway directors. No group of men in existence can really do so much harm to this country as the few hundreds who control the great network of our internal communications. Their power is so great that the trading community naturally regard their operations with a jealous eye. They may, however, comfort themselves with the reflection that what promotes the prosperity of Great Britain must promote the prosperity of its railways. But the traders who complain, should not forget that in no other country in the world are goods and minerals conveyed with so much speed, certainty, safety, and honesty, as in England. Such advantages are worth paying for; and the traders would, we believe, be the first to complain if they found that a reduction in tariffs involved inferior service.

We have made no allusion to the provisions of Mr. Mundella's bill, because the daily press has put its readers in possession of the facts concerning it. We express no opinion concerning its merits or demerits. It will, no doubt, undergo large modifications in various ways before it can become law, and it will be time enough further on to speak fully concerning it. We have preferred to deal with the relations of railway companies and traders on broad principles. Railway directors maintain that State interference with their operations is unjustifiable. We hold that they have brought such interference on themselves, and that the State is perfectly justified in ascertaining whether the companies are or are not misusing the rights which the State has conferred. We by no means advocate a violent interference with the companies. We cannot see that Parliament, without due inquiry, would be justified in making sweeping reductions, or, indeed, any reductions in railway rates. But we do not for a moment believe that it contemplates doing anything of the kind. The circulars issued by railway directors speak of confiscation in a way quite unwarranted. The trading community has its rights as well as the railway companies, and the rights of both ought to be, and we have no doubt will be, respected in future legislation. But the commercial exigencies of the country are such that it is quite impossible that the railway companies could much longer escape from an inquiry intended to determine what part, if any, they have taken in bringing about the existing depression of trade. No Act of Parliament can be passed until the public is placed in possession of both sides of the case. It is at least certain that the railway companies are taking care to make themselves heard, and we may regard it as clear that the enormous interest possessed by the railway companies will suffice to protect them from even the shadow of an injustice. They may, perhaps, regard the matter from a different point of view; but the traders of Great Britain are quite as important as the railway companies, and their opinion on this point will be entitled to as much respect.

RAILWAY REGULATIONS IN GERMANY.

Herr Wichert lately called attention—at a meeting of the Berlin Railway Association—to the question of the introduction of continuous brakes on the Prussian State railways. The new regulations, which came into force on April 1st, necessitate the application of continuous brakes to all trains running at thirty-seven and a-half miles per hour and at higher rates of speed. At the same time the line at the side of the carriages is no longer required, provided the continuous brakes can be applied from the separate compartments. Herr Wichert expressed the opinion that this new regulation must sooner or later be applied to all passenger trains without distinction as to speed. For railways of secondary importance Heberlein's brake has been adopted. These lines being apart from each other, in most instances, complete uniformity of brake appliances is not indispensable. The case is, however, different with main lines, on which Carpenter's air-pressure system has been introduced. Up to last October about thirty per cent. of all the passenger trains on the Prussian State railways had been provided with continuous brakes. In all cases where they had been applied they had been found to act. Within a given period 2307 unexpected applications of the brake had taken place. Actual danger was impending in twenty-eight cases, in eighteen of which the stoppage had been caused by the driver, in nine by signals from passengers, and in one the action of the brake had been automatic. Improvements have been made by Messrs. Siemens and Halske, of Berlin, in the apparatus now largely used in Germany for controlling the speed of trains. An electric communication exists between given sections of the railways and certain stations by means of which the speed at which a train is going can be recorded. This system—though of admitted utility—was attended by various defects which have now been obviated by the use of two connected vessels containing quicksilver, one for receiving the pressure of the rails and the other for establishing the electric current by means of the rise of the quicksilver. The firm named has already furnished 1505 of these appliances and 318 station instruments for recording the results.

THE HAWKESBURY BRIDGE.

Either the Union Bridge Company, of New York, has very much under-estimated the work to be done in the construction of the Hawkesbury Bridge, in New South Wales, or our English engineers have not only over-estimated it, but put on a big sum for possible difficulties in constructing foundations 185ft. below high water. The site of the bridge is across the tidal estuary about thirty miles above Sydney, and the depth of mud and sand very great. The Union Company's tender of £327,000 was accepted as the lowest; but in accepting it, alterations requiring an increase of £40,000 were, we believe, stipulated. This will bring the cost up to £367,000, without any of the extras which are no doubt to be built up as the work proceeds. How the New South Wales people will like the bridge twenty years after its completion of course remains to be seen; but how they will like some kinds of tension members connected with it, commonly called wire pullers, will perhaps be seen much earlier. It is to be regretted that this bridge is not to be constructed by English constructors; but they are better without it if they could not get a fair price in a fair way. English firms of repute do not seek extras; but it must also be said that some of them want what, in the face of world-wide competition, are prohibitory prices for what they do.

FOREIGN COMPETITION IN ENGLAND.

Carrying the war into the enemy's country is a favourite policy of clever generals—the generals of commerce as well as of conflict. It is no secret that German travellers, with specialities in cheap cutlery and hardware, regularly visit and do splendid business with English houses; that cargo after cargo of Belgian iron is delivered in the heart of the English iron districts; that Norwegian and Swedish doors and window-frames are sent over in shiploads for British house-building. The latest development of foreign competition is the establishment at Sheffield of a German cutlery firm. This has been done within the last few days. In a leading Sheffield thoroughfare may be seen a shop over which runs the legend, "F——— Bros, Merchants, Importers of all kinds of Foreign Cutlery, Manufacturers of all kinds of Scissors. Works: Solingen, Rhenish Prussia." Sheffield artisans will now have an opportunity of seeing what their Solingen brethren can do. An edge-tool manufacturer recently told his grinders, when they refused a concession in wages, that the German and Sheffield workmen were now face to face, and the struggle would be to the strongest. A German cutlery shop in the capital of English cutlery is an event which brings the struggle appreciably nearer.

LITERATURE.

Select Methods in Chemical Analysis. By W. Crookes, F.R.S. 2nd Edition. 8vo, 725 pp. London: Longmans. 1886.

The former edition of this work, published about ten years since, originated in a reprint of the articles on chemical analysis that appeared in the *Chemical News* during the earlier years of the author's editorship of that journal. That edition having been exhausted, it is now followed by a successor in which the old text is not merely revised, but a great part has been re-written. The great number of new methods that have latterly been introduced into laboratory practice have also rendered necessary a considerable increase in the bulk of the volume; and the style, both as regards type and paper, is a considerable improvement upon its predecessor.

It will be of course unnecessary to go into the contents in detail, and, in fact, such a notice would be unsuited to our columns, as the work is especially one for laboratory reference. The most interesting of the new additions is probably that relating to the cerium group of metals, which have long formed a favourite subject of investigation with the author, and he has done well in reprinting *in extenso* his Bakerian lecture on the detection and wide distribution of yttria, delivered before the Royal Society in 1883. In this it is shown, by spectroscopic methods, that the rare earth yttria is present in almost every substance containing lime, though in very variable proportions, ranging from about 1 in 200 of lime in pink coral to 1 in 1,000,000 in dolomite and tobacco ash. The characteristic property which indicates the presence of the most minute traces of this earth is a broad band of a citron tint which occurs in the spectrum of its compounds when rendered phosphorescent by an electric discharge in a very high vacuum.

The newer analytical modifications introduced into metallurgical practice are given in considerable detail. Possibly in this part a more judicious selection would have been of value. It is also to be regretted that references to the original publications have not been given, as it is not always clear whether the process is new or goes back to the original publication. By a curious oversight the method of blowpipe cupellation, to which nine pages are devoted, is attributed to the late Mr. D. Forbes; whereas the description differs scarcely, if at all from the series of operations as practised by Plattner at Freiberg thirty years ago or more. The principal apparent difference is that the cupellation block has three notches underneath instead of four. It may also be doubted whether the statement of the preface—that only such methods are given as have been proved in his own laboratory—applies in all cases. For instance, is the author satisfied that Tantin's method of estimating phosphorus in iron by volatilising it during solution in hydrochloric acid as phosphoreted hydrogen is accurate? If recent American investigations are to be trusted, only an insignificant fraction of the total phosphorus can be so volatilised.

A matter of considerable interest which is brought prominently into notice is the substitution of magnesium for zinc, as a reducing agent whereby iron and many other metals may be precipitated in the metallic state with the greatest ease; and as metallic magnesium may be obtained in a state of great purity, the resulting metals are also extremely pure. The chapter on new methods of manipulation contains descriptions of the newer methods of filtration under pressure, and of the steps that have been taken to do without filter paper, or to reduce its use to a minimum by substituting discs and perforated plates for the ordinary conical filters and funnels. Dr. Carmichael's apparatus based upon this principle is very fully described. The use of fluids of mean density in the separation of mixed minerals for analysis is very scantily treated, only Sondstedt's method with solutions of iodide of potassium and iodide of mercury being noticed.

The volume closes with a series of useful tables, including those for the conversion of French into English measures. In the latter the ton of 2240 lb. figures as a long ton, together with a short ton of 2000 lb. Both these statements are incorrect. The latter is merely a conventional American weight, and is spoken of as a net ton in the country of its origin. The only ton recognised as the Imperial standard is that of 2240 lb. A long ton is a far larger weight in customary use in collieries and ironworks. Possibly the terms used by the author may be more appropriate, but they have the demerit of not being authorised.

Laxton's Builders' Price-book for 1886. Containing above 72,000 prices. Originally compiled by William Laxton. Sixty-ninth edition. London: Kelly and Co. 1886.

The continued popularity of Laxton's Price-book is in itself a sufficient guarantee of the satisfactory way in which it meets the requirements. To check over 72,000 prices is a work which we will not undertake, and to find errors in them we should evidently have to look over them all, for we found none after looking through a large number. In a few cases a little more definition is required, as, for instance, in speaking of stone walling, a price is given as a guide, assuming the stone to be "of medium hardness or texture." As a guide, the information would in this and other cases be more satisfactory if an example were given; for instance, in the above case, the words "such as Portland" or as "Bath stone." There are not many engravings in the book, but those that are might be renewed with advantage. The present edition has received several additions and emendations, which bring it down to date and make it as hitherto a builder's necessary.

CONTINUOUS BRAKES IN FRANCE.

We have several times drawn attention to the contrast noticeable in the way things are done concerning railways in France and in this country. We are now favoured with a further illustration which will certainly appeal to most of our readers as a most sensible manner of treating the important question of railway brakes, however superior we may consider our management in other respect. The French Minister of Public Works has addressed the following circular to the railway companies, and we commend it to the attention of Parliament and our own Board of Trade:—

"Paris, March 29th.

"Gentlemen,—In accordance with the opinion of the Commission instituted in 1879 for the purpose of investigating the means of preventing railway accidents, a Ministerial circular of September 13th, 1880, prescribed, amongst other measures, 'the fitting up with continuous brakes of all passenger trains, which, at their highest speed, reach 60 kilometres—37½ miles—per hour, and, in addition to this, the continuance of the counter-pressure system.'

"If the Administration in the first instance thus limited the use of these brakes, it was solely, as mentioned in another circular of January 24th, 1885, with the object of not forcing the companies to face in too short a time the considerable expenses which would have been required for the immediate equipment of all their express trains. But as at this moment the installations prescribed by the circular of 1880 have been completed, and since all vehicles forming fast and express trains are fitted with continuous brakes, the moment appears to me to have arrived when the application of this appliance should be extended to all vehicles forming part of passenger trains.

"I have therefore to beg you to undertake the application of continuous brakes to all passenger carriages and all other vehicles run in express trains, such as luggage-vans, mail-vans, horse boxes, carriage trucks, milk wagons, fish trucks, and fruit trucks, &c.; and so carry on this work with the necessary expedition to insure that after a period of two years at the furthest, all passenger trains, including therein also omnibus trains, are provided with continuous brakes. I beg you also in the same period to fit continuous brakes and the counter-pressure apparatus on all engines intended for the service of these trains. You will be good enough to acknowledge receipt of this circular.—Pray accept, &c.,

"The Minister of Public Works.

"(Signed) Ch. Baihaut."

It is certainly to be deplored that it should have required the disastrous accident at Monte Carlo—where the train was not fitted with brakes—to bring about this circular; but much more serious calamities have occurred in this country, with the result that the question of brakes still remains at the discretion of the railway companies, who in many cases continue to treat it as one merely of taste, fancy, and expediency. A number of the companies, instead of working on some principle with a view to the harmonious action recommended by the Board of

Trade many years ago, have, on the contrary, appeared anxious to avoid anything like real harmony, and as rather concerned to support the opinions of their advisers, however mistaken, without regard to the safety of the public. It would appear that the French are much more easily startled than ourselves—or, in other words, they attach a higher value to the lives of the public than does our own Government. It is, to say the least, however, not creditable that the requisite safeguards should be deferred until a calamity of a sufficiently shocking character, resulting in the loss of sufficiently eminent lives, has taken place.

PRIVATE BILL LEGISLATION.

More than one of the Select Committees of the House of Commons have since last week suspended their inquiries for several days, "for the convenience of parties;" but, on the whole, rapid progress is being made with the examination of Private Bills in the Committee-rooms. During the last few days Committees of both Houses have been sitting, as many as half-a-dozen proceeding in the Commons simultaneously. Under these circumstances, and speaking generally, few of the schemes involving obstinate contention, a substantial inroad has been effected in the formidable array of Bills presented this session. Similar advance is being made in the two Chambers, and a few Bills have received the Royal assent, among the number being the Highgate and Kilburn Open Spaces Bill.

The House of Lords has read a third time and passed down to the Lower House (among others) the Tyne Improvement Acts Amendment Bill, the Bill for increasing the powers of the Clyde Navigation Trustees and the Clyde Pilot Board, and for the purchase of lands for completing the railway authorised by the Clyde Navigation Act of 1883; the Bill for the abandonment of the Midland and Central Wales Junction Railway; the Bill to revive the powers to extend the periods for the compulsory purchase of lands for, and the construction of, the Oswestry and Llangynog Railway; the Bill authorising the Shanklin and Chale Railway Company to extend their line to Freshwater; the Bill for conferring further powers on the Lanarkshire Railway Company; the Brighton, Rottingdean, and Newhaven Direct Railway Bill, the Bute Docks (Cardiff) Further Powers Bill, the Edinburgh Improvement Bill, the Forth Railway Bill, and the Beaconsfield, Uxbridge, and Harrow Railway Bill.

In the House of Commons the following Bills have been dealt with since last week:—Second Readings:—Lynton Railway Bill, Portsmouth and Hayling Railway Bill, Bridgewater Railway Bill, Bray and Enniskerry Light Railway Bill; Dublin, Wicklow, and Wexford Railway Bill; Folkestone, Sandgate, and Hythe Railway Bill; Leamington Corporation Bill, Rhondda and Swansea Railway Bill, Stapenhill Railway Bill, Swansea Harbour Bill. Third Reading:—Liverpool Corporation Bill; London, Chatham, and Dover Railway Bill; Cleator and Workington Railway Bill, London and South-Western Railway Bill, Marple Local Board Gas Bill, West Durham and Tyne Railway Bill.

The Carlisle Corporation Bill has been reported to the House of Commons as not complying with the Standing Orders, while the Seacombe, Hoylake, and Deeside Railway Bill has become unopposed since its remission to a Select Committee of the same House. In the same way, after reference to a Committee, the Ormskirk Railway, Mersey Railway, and St. Helen's and Wigan Junction Railway Bills have become unopposed, and will therefore pass into law with little further trouble.

One of the most interesting of the Corporation Bills now before a Select Committee is that promoted by the Oldham Corporation, dealing with gas, water, and other matters. The water part of the scheme has been strongly resisted by various local authorities in that part of the country, and is of sufficient interest for a brief description. According to Mr. Pember, the Parliamentary and municipal borough of Oldham extends over 4799 acres, and the total area of the water supply is 16,000 acres, for a population of 192,000. The quantity of water supplied is 340 million gallons, or 120 millions more than in 1875. The waterworks were transferred to the Corporation in 1883, and since then have been largely extended; but, in spite of extensions, the district was on the verge of a water famine in 1884, Oldham being at a considerable height above the sea, and having no real watershed of its own. To meet the increasing needs it is proposed to erect two new reservoirs in the Castleshaw district, three in the Deanhead district, and additional storage works in the watersheds already possessed by the Corporation. By these means it is calculated that at the present rate of increase in demand the borough will be secured a supply of twenty-five gallons a day per head for the next nineteen years. The opponents have urged that the proposed works are not necessary, and that even if a further supply is required it can be obtained from the Thirlmere works; but the reply to that is that to obtain water for Oldham from the Thirlmere aqueduct would be too costly an undertaking, as every gallon would have to be pumped up between 400ft. and 500ft. Moreover, it was intended that the Thirlmere system should be drawn upon primarily by towns having an equal right to that source with Manchester, and not that other towns should not take advantage of any natural supply they could reach. The contest has already engaged the attention of a Committee for more than a dozen days, and is not yet ended, the inquiry having been suspended for a week. There were at one time twenty petitions against the Bill.

Although the Northfleet and Gravesend Dock Bill has been rejected by the Standing Orders Committee of the House of Lords, the promoters hope to induce their lordships to recommit the measure. With a view to this, they visited Earl Granville a few days ago to solicit his assistance. The noble lord promised to consider their request, but declined to pledge himself on the subject.

It is stated that the North Metropolitan Tramways Company intends to ask Parliament for leave to insert in its No. 1 Bill, now proceeding in the Commons, a clause empowering them to use electricity as a power for moving its trams.

The Select House of Commons Committee upon the several Metropolitan Water Bills has commenced its inquiry, Lord Claude Hamilton being chairman. The South Lambeth Company's Bill was the first taken, and after a futile attempt by two of the other companies to postpone the preamble in order that the three Bills might be taken together, Mr. Pember explained that the object of the South Lambeth Bill was to borrow £150,000 for the construction of certain mains and pipes to meet an increase of new roads and new houses; the construction of filter-beds in Surrey; the construction of a new storage covered reservoir at Norwood; new storage reservoir at Brixton; a reservoir at Selhurst; and the extension of the spring water supply at Mosley and Brixton. The expenditure for which capital was now asked was a matter of 10 per cent. on the capital of the company, and was not, therefore, a very large matter. It was shown to be *primâ facie* necessary by the fact that the supply had during the last few years enormously increased, and was still fast increasing. In 1871 the company was only supplying 12,000,000 gallons of water per day, whereas in 1886 the supply had grown to 20,000,000 gallons. In other words, it had increased 66 per cent. in fifteen years. The company's expenditure from the month of March, 1880, to September, 1885, was £250,000. The accounts of the company showed that in March, 1886, it had not more than £27,000 in hand, and the expenditure in capital account was still going on, and very little of it would be available for the purpose for which the £150,000 was wanted. He did not estimate that this £150,000 would last more than four or five years, and a great deal of it would be spent in improving the purity of the water, and would, therefore, yield no return to the company.

The Municipal Corporation Association are promoting a bill for remedying the present unsatisfactory condition of the law respecting the rating of waterworks, and it has been arranged that the measure shall be referred to a Select Committee in order that the question may be very thoroughly investigated.

When the Nottingham Suburban Railway Bill comes before a Committee, a new clause will be proposed, confirming an agreement that has been come to between the promoters and the Great Northern Railway Company, for the working, use, and maintenance of the Suburban Railway by the Great Northern Company. The clause will also provide, among other things, for the payment by the Great Northern Company to the Suburban Company of certain amounts in each year, to make up deficits below a specified sum in the receipts for the year.

In examination before the Select Committee on the River Lea, Major Flowers, engineer to the Lea Conservancy, mentioning that the watershed of the river extended to 600 square miles, explained that the first pollution of the river was met with at Lea Marsh Farm, but that was now entirely abated. The next pollution was at Luton; and believing that no chemical process by itself would be sufficient to deal with the foul water, he had advised the authorities to adopt the sewage-farm plan. This they had done, purchasing altogether seventy-six acres for that purpose. Above the first intake of the New River Company the water was as good as river water could be, but between Hertford and Ware, where the Manifold Ditch fell into one of the affluents, the water was again foul, and the same might be said as to Cheshunt, Waltham Abbey, and other points. He advised the employment of river police, to protect the river intakes; and mentioned that Sir F. Bolton, having analysed the water at the East London Company's works and at other points, had found but few traces of pollution. He further recommended that that the pollution should be taken into the main sewer, and that an independent branch sewer running up towards Barnet should be constructed, with its discharge into the main drain.

As we have predicted, the opposition to the Ship Canal Bill is to be renewed in the House of Lords by a motion to refuse the second reading—the motion probably being made by Lord Redesdale, who has always been hostile to the scheme. If this attack fails, the resistance to the Bill will be continued in the Committee-room by means of petitions from, at all events, the London and North-Western Railway Company, the Mersey Docks Board, and the Corporation of Liverpool.

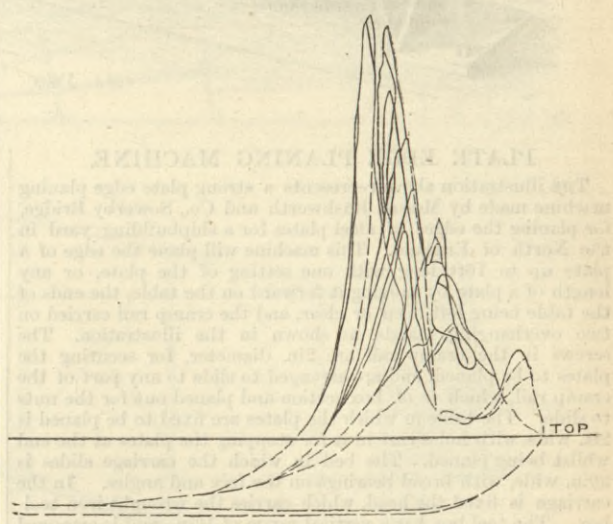
In like manner the Bill for enabling the Salford Corporation to invest £250,000 in the canal undertaking is to be stoutly resisted by some of the great railway companies. For example, the London and North-Western Company has presented a petition against the Bill. As owners and occupiers of property and ratepayers in Salford, it protests against the proposed authorisation as contrary and repugnant to sound policy and to the practice of Parliament, as instanced in this very case by the fact that the first Committee on the Ship Canal Bill struck out clauses enabling corporations and local authorities to subscribe to the undertaking. They further urge that the Corporation are seeking power to tax the petitioners for the furtherance of a scheme avowedly and expressly designed to divert traffic for the petitioners' railways and to injure their property rights and interests; and while objecting to the Bill on the general ground that municipal authorities ought not to be allowed to subscribe to commercial enterprises, the petitioners object to the Bill "on the further ground that the undertaking is in no sense one of a local character, or one the ultimate success of which the Corporation can in any way promote and ensure, and which, in the opinion of the petitioners, is more than doubtful, either as regards its own financial prospects or as regards any benefit which it would confer on the borough of Salford or the inhabitants and ratepayers thereof." The Bill is also objectionable, they further contend, on the ground that if Parliament were once to sanction the principle that municipal authorities might invest the moneys of the ratepayers in speculative projects and apply them in any way outside their proper functions it would open the door to a vast amount of similar legislation, and the petitioners submit it is wholly inexpedient to expend money levied from the ratepayers in support of speculative projects, and as a final shot, the petitioners point out that the Manchester Corporation, although they subscribed to the cost of promoting the Canal Bill, have not taken any such steps as the Salford Corporation are taking, but have left those who have faith in the enterprise to provide the funds according to the measure of their confidence. The Lancashire and Yorkshire Railway Company has likewise petitioned against the Bill, and it is clear that this measure, like the Canal Payment of Interest Bill, has still to face troublesome weather.

Since we last referred to the subject two Bills, besides that which we then described, have been introduced to amend the Electric Lighting Act of 1882. Each is short, and aims only at altering the twenty-seventh clause of the Act—that enabling a local authority to acquire an electric lighting undertaking at the end of twenty-one years—in contrast to Lord Rayleigh's Bill, which seeks to place the electric light in the same position as gas as to powers privileges, and obligations. Lord Bury in his Bill proposes to repeal the twenty-seventh clause entirely, and in lieu thereof to enact that "Where any undertakers are authorised by a provisional order or special Act to supply electricity within any area, any local authority within whose jurisdiction such area or any part thereof is situated may, within six months after the expiration of a period of forty-one years from the date of the passing of the Act confirming such provisional order or of such special Act, and within six months after the expiration of every subsequent period of seven years, by notice in writing, require such undertakers to sell, and thereupon such undertakers shall sell to them their undertaking, or so much of the same as is within such jurisdiction, upon terms of paying the then value thereof as a going concern." If any difference arises with respect to the value of the undertaking it is to be settled by arbitration, and due regard is to be had to the nature and then condition and state of repair of the buildings, materials, and so on, and to the suitability of the works for their purpose, while the Board of Trade is to determine various other points of detail. The other—and third—Bill is introduced on behalf of the Government by Lord Houghton, and substantially amounts to this:—The prescribed period of twenty-one years is to be excised from the 27th clause and forty-one years substituted, with, however, the proviso that where no period is so specified the prescribed period shall be deemed to be a period of thirty years, and that no period exceeding thirty years shall be so specified in relation to the purchase of any undertaking, or part thereof, except with the consent of the local authority within whose jurisdiction such undertaking, or part thereof, will be. The Bill further provides that the successive periods for acquisition after the thirty or forty-one years—as the case may be—shall be ten years terms, instead of seven, as provided in the existing Act. All three Bills have been referred to a Select Committee of the House of Lords.

The Thirlmere Waterworks, authorised for the benefit of Manchester seven or eight years ago, have only recently been commenced, and will take another five years to complete; but the prospective supply is already being utilised against current schemes for improved water supply. For instance, in opposing the Oldham Improvement Bill, described above, Mr. Stephens, Q.C., argued that Oldham ought not to be allowed to take water from the sources contemplated—first, because the supply was needed by other districts; and secondly (and mainly), because, under the Thirlemere Act, Manchester was bound to give a supply to all places situated in the neighbourhood of the aqueduct. Mr. Pember, Q.C., observed that this aqueduct would be 100 miles long, and would have a population of 1,000,000 along its course; but Mr. Stephens contended that most of the towns referred to had already an ample supply, Oldham itself having twenty-seven gallons per head per day, and therefore the Thirlemere works would be abundantly equal to the demands made upon them.

A CONDENSER PUZZLE.

The annexed is a diagram from the air pump referred to in the letter under this title published in The Engineer last week. The



Taken between Delivery Valve and Bucket—Scale $\frac{1}{32}$ = 1 lb.

diagram needs no description that will not be found in the letter signed "Puzzled."

VISCOSITY OF AIR.

At a recent meeting of the Royal Society a paper on "The Coefficient of Viscosity of Air," by Herbert Tomlinson, B.A., was communicated by Professor G. G. Stokes, F.R.S. The author employed the torsional vibrations of cylinders and spheres, suspended vertically from a horizontal cylindrical bar, and oscillating in a sufficiently unconfined space. The bar was suspended by a rather fine wire of copper or silver attached to its centre, which, after having been previously subjected to a certain preliminary treatment with a view of reducing the internal molecular friction, was set in vibration. The coefficient of viscosity of air was obtained from observations of the diminution of the amplitude of vibration, produced by the resistance of the air to the oscillating spheres or cylinders attached to the horizontal bar, arrangements having been made so that the vibration-period of the wire should remain the same, whether the cylinders or spheres were hanging from the bar or not. In deducing the value of the coefficient of viscosity from the logarithmic decrement, the author has availed himself of the mathematical investigations of Professor G. G. Stokes.*

Five sets of experiments were made with hollow cylinders and wooden spheres, in the construction and measurement of which considerable care was taken. When the cylinders were used arrangements were made to eliminate the effect of the friction of the air on their ends. The following are the results:—

Cylinders.

Length in centimetres.	Diameter in centimetres.	Vibration-period in seconds.	Temperature of the air in degrees Centigrade.	Coefficient of viscosity of the air in C.G.S. units.
60·875	2·5636	6·8373	12·02	0·00018171
60·885	0·9636	7·0590	14·63	0·00018122
60·875	2·5636	3·0193	11·69	0·00018024
53·175	2·5636	2·9994	10·64	0·00017845

Spheres.

6·364	2·8801	9·35	0·00017820

Maxwell has proved† that the coefficient of viscosity of air is independent of the pressure and directly proportional to the absolute temperature. We can therefore calculate from the above data what would be the value of the coefficient of viscosity at 0 deg. C.; and when this is done, in the case of each of the five sets of experiments, we obtain the following values:—

Set of experiments.	Coefficient of viscosity of air at 0 deg. C.
1st	0 00017404
2nd	0 00017201
3rd	0 00017284
4th	0 00017359
5th	0 00017230

The mean of these numbers is 0 00017296, with a probable error of only 0·14 per cent. The formula for finding μ_t, the coefficient of viscosity of air at the temperature t deg. C., is therefore

$$\mu_t = 0{\cdot}00017296 \left(1 + \frac{t}{273}\right).$$

The value of the coefficient of viscosity of air at 0 deg. C. given above, though much nearer to that obtained by Maxwell than any which has been got by other observers, nevertheless differs from it by more than 8 per cent.‡

* See Professor Stokes' paper "On the Effect of the Internal Friction of Fluids on the Motion of Pendulums," "Trans." Camb. Phil. Soc., vol. ix., Part II., 1850.

† "Phil. Trans.," 1866, vol. clvi., Part I.

‡ Professor Stokes in a note at the end of the paper, has shown that a very small deviation from horizontality of the movable discs used by Maxwell would make the value of the coefficient obtained by him 8 per cent. too great.

PLATE EDGE PLANING MACHINE.

MESSRS. RUSHWORTH AND CO., ENGINEERS, SOWERBY BRIDGE.

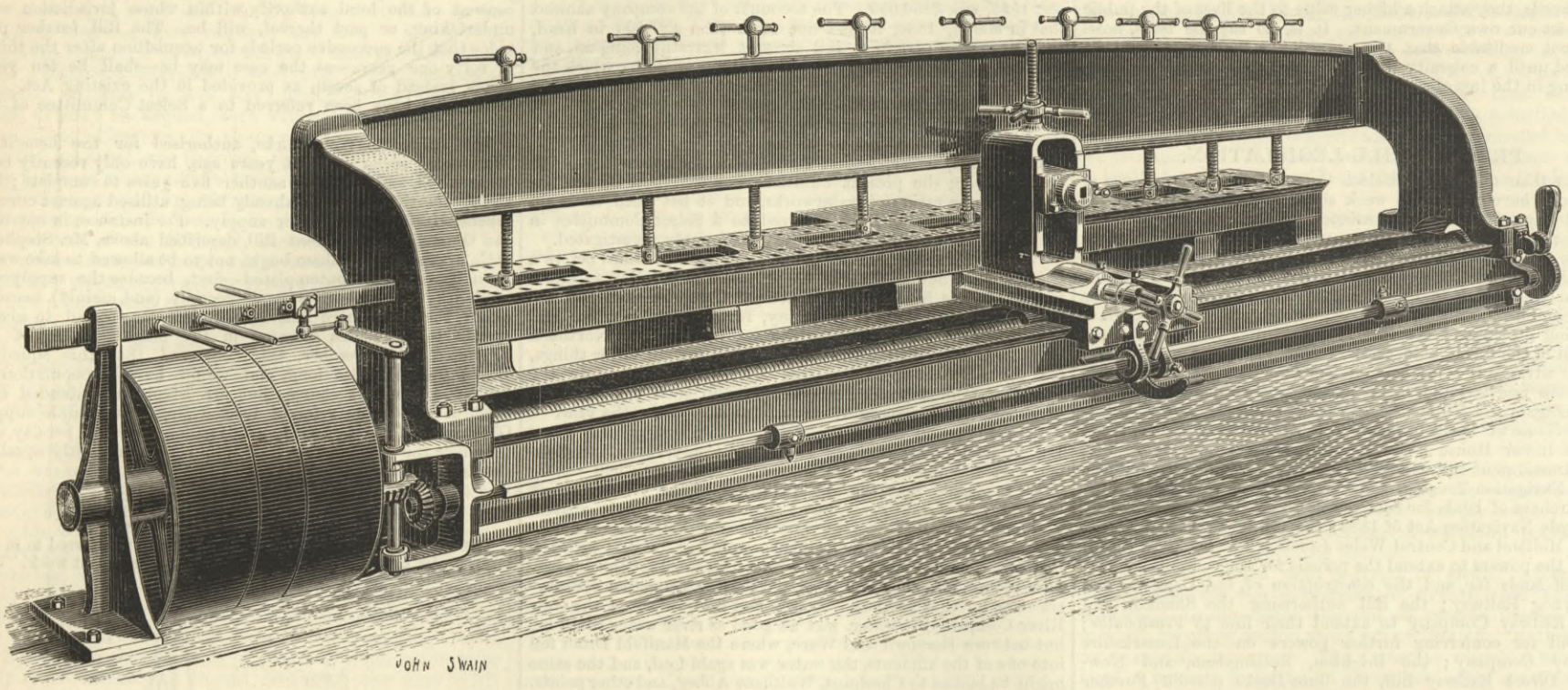


PLATE EDGE PLANING MACHINE.

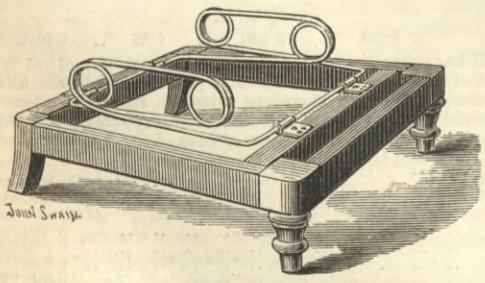
The illustration above represents a strong plate edge planing machine made by Messrs. Rushworth and Co., Sowerby Bridge, for planing the edges of steel plates for a shipbuilding yard in the North of England. This machine will plane the edge of a plate up to 16ft. long with one setting of the plate, or any length of a plate by moving it forward on the table, the ends of the table being left open or clear, and the cramp rail carried on two overhanging stands, as shown in the illustration. The screws in the cramp rail are 2in. diameter, for securing the plates to be planed, and are arranged to slide to any part of the cramp rail, which is of box section and planed out for the nuts to slide. The table in which the plates are fixed to be planed is 2ft. wide, with holes cast in it for stopping the plates at the end whilst being planed. The bed in which the carriage slides is 20in. wide, with broad bearings on the face and angles. In the carriage is fixed the head, which carries the wrought iron tool-box. The tool-box has a vertical range of 10in., and is arranged to turn over to cut both ways, and also with a transverse feed of 6in.

The wrought iron tool box is arranged to receive a steel cutting tool 1½in. square. The main screw is of steel and 4½in. diameter, and works in phosphor bronze bearings at each end, and is arranged with loose cap at one end so that the screw can be lifted out when required by drawing it out of one bearing, &c. Under the screw is a continuous bearing, bored out full length, for supporting, it and to insure the screw being always lubricated. The nut, which is under the carriage, is of phosphor bronze, 20in. long, and chased out to fit the screw, having a large wearing surface and without any backlash. At the extreme end of the screw is fixed a tail bar or bridge, with an adjustable steel pin to take the slightest wear out of the screw and keep it in its own position. At the other end of the bed is a bridge, similar, but with two gun-metal washers 7½in. diameter to take the thrust, so that the stress is all within the main casting and not dependent on the separate arm which supports the screw at the pulley end. The driving pulleys are 30in. diameter for a 5in. belt with self-acting reverse motion, as shown in the illustration.

The machine can be stopped or started either at the end or by a handle on the carriage at the will of the workman, and the square shaft for reversing is got well out of the way. The machine can be made with a self-acting feed, also self-acting for turning over the tool if required. Its weight is 10 tons.

RAILWAY CARRIAGE SEAT SPRINGS.

The springs illustrated by the accompanying engravings are made by Mr. J. Harrington, Coventry, for chair and railway carriage seats. The form of the spring gives it a very large range of movement, and a seat mounted upon a pair of them may have a truly vertical movement or one in any direction.



The springs are remarkable for their simplicity and great range of flexure, and are adapted to many purposes. As applied to chairs and railway carriage seats they are exhibited at the Royal Aquarium at the present time, where also some remarkable specimens of Japan or lacquering in smooth and egg-shell, black or brown, are also shown by Mr. Harrington.

THE FIGEE STEAM PILE DRIVER.

Messrs. Figee Brothers, of Haarlem, Holland, exhibited at Antwerp last year a steam pile driver, which is illustrated by the accompanying engraving. The *Genie Civil* describes it as made to drive piles with a force of from 500 to 1200 kilogrammes, whatever that may mean. The tup consists of a cast iron cylinder—Fig. 1—provided with a piston, as shown, the piston-rod being hollow for the admission of steam, and fixed at its upper end to the pile-driver framing. The cock above the bracket which holds the piston-rod is provided with three-way ports, and form steam and exhaust valve in one, and also valve by which the tup can be held in any position. The valve may be worked by hand, and when the pile to be driven

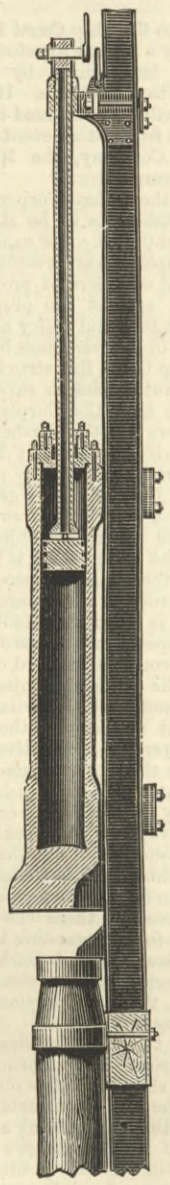


Fig. 1

Fig. 2

is fairly planted, it may be worked automatically. The bracket attached to the tee iron frame to hold the piston-rod is, of course, movable.

THE SOUTH AFRICAN EXHIBITION.

The following particulars concerning the South African Exhibition, held at Port Elizabeth in the months of December and January last, and which proved very successful, and resulted in a surplus after payment of all expenses, has been sent us by Mr. S. H. Farrar, Port Elizabeth, of Messrs. Howard Farrar and Co., Cornhill, London, and South Africa. The main object of the Exhibition was to collect together samples of the products and manufactures of South Africa, with a view to selecting from amongst them an assortment of exhibits which should enable South Africa to make a respectable figure at the approaching Colonial Exhibition at South Kensington.

The Exhibition was held in the Market Buildings, which are admirably adapted for such purposes. These buildings, all under iron roofs, designed by Mr. J. Wolfe Barry, consist of the following departments, all of which were utilised during the Exhibition :—(1) The Wool Market, 160ft. by 100ft., which was used for the machinery exhibits, and for the electric light plant. (2) The Vegetable Market, 150ft. by 100ft., used for general exhibits, such as wines, harness, leather, furniture, &c. A wide gallery runs round the hall, and was utilised for the display of paintings, photographs, mechanical and architectural drawings, &c. (3) The Ostrich Feather Market, 180ft. by 90ft., which was devoted to exhibits of wool, mohair, feathers, native productions, curios, &c. Underneath the market extends a fine range of cellars, occupied by the refreshment rooms, offices, wine sample rooms, &c.

The electric light installation, being the first temporary installation on a large scale in South Africa, merits a brief description. The plant consists of a 25-horse power Blake multitubular boiler, which supplied steam to two 8in. Tower engines, with Mather and Platt's dynamos attached. A third Tower engine, with Crompton arc dynamo, was arranged to take steam from this boiler, but was not required. An 8-horse power portable engine, by Clayton and Shuttleworth, drove a Bürgin dynamo direct for feeding the arc lamps. The distribution was as follows :—One Tower engine and dynamo fed 141 20-candle power Woodhouse and Rawson incandescent lamps in the Ostrich Feather Market. One Tower engine and dynamo fed 143 20-candle power lamps by same makers, distributed in the corridors, refreshment rooms, offices, and Vegetable Market. The Bürgin dynamo fed four 2000-candle power Crompton D.D. arc lamps fixed in the Wool Market, four similar lamps fixed in the Vegetable Market, and the lamp suspended before the main entrance to the Exhibition. The arc machine current was 15 ampères, with an electro-motive force of 50 volts for lamps, and 2·3 volts for leads. The electro-motive force of the Mather and Platt dynamos was from 92 to 100 volts, each lamp requiring a current of ·5 ampère.

After the first few days, colonial coal was used partially for firing, and although not equal to Welsh steam coal, owing to the quantity of clinker formed, it will undoubtedly ere long render the colony self-supplying in this respect. The plant was shipped from England by the contractors in about fourteen days after receipt of order, and was erected in working order in Port Elizabeth eight days after its arrival. The Bürgin dynamo was taken over by the Town Council at the close of the Exhibition to permanently light the Vegetable or the Ostrich Feather Market.

The exhibits of gold and diamonds were such as are rarely seen, the value of the diamonds shown being estimated at from £50,000 to £60,000. Large quantities of gold, gold-bearing quartz, &c., were shown by the Standard Bank and various Transvaal gold companies.

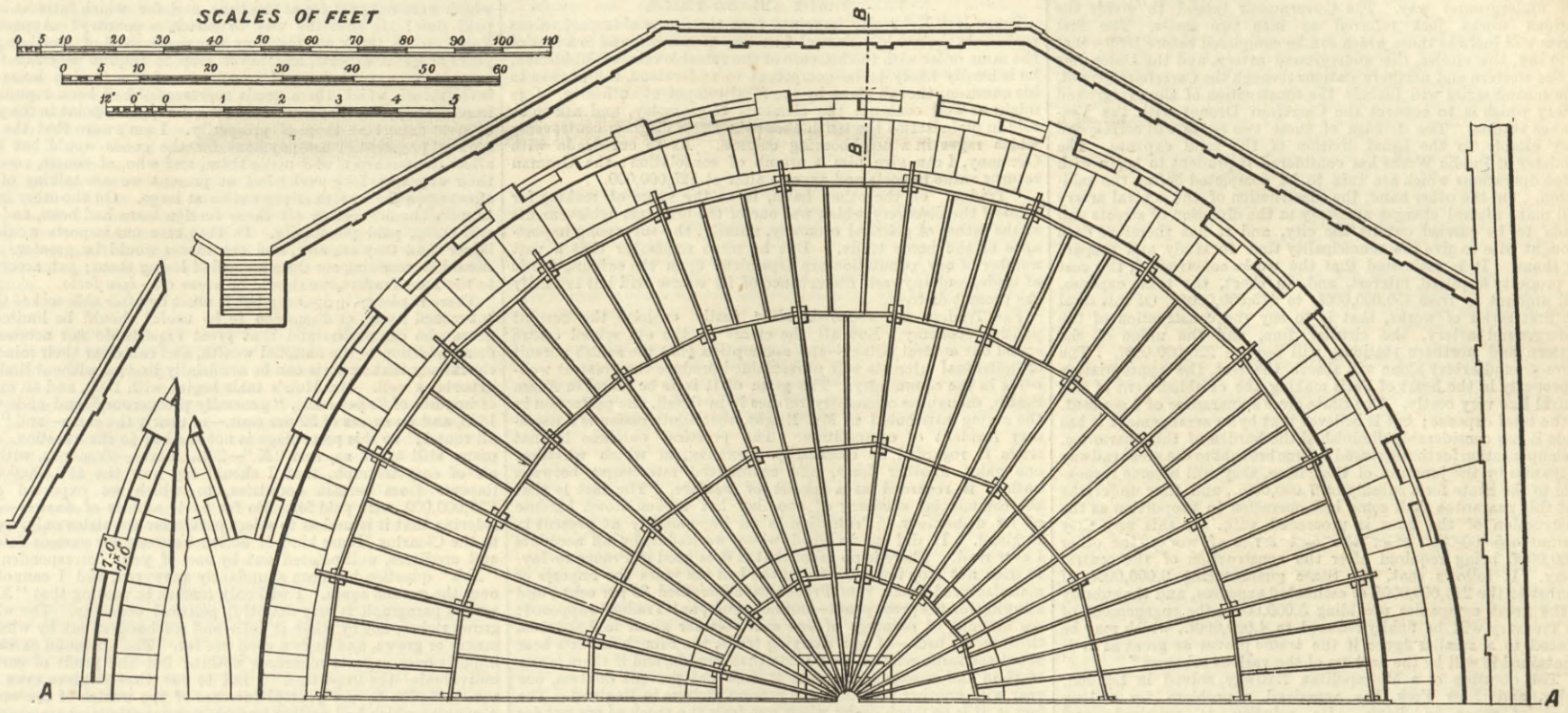
One of the most interesting exhibits was a complete set of models, shown by the Kimberley Committee. Amongst them was a model mine, composed of the actual "blue stuff," as it is called, and showing the hauling-gear, with standing ropes, tubs, &c., fixed in position. They also showed a complete model representing a modern washing plant, for washing the "blue" and sorting diamonds. These models are on their way to this country, and will be exhibited at work in the South-African Court at the forthcoming exhibition in London. The principal processes of the diamond mining industry have been fully described in a paper read by Mr. Paxman a short time ago, before the Institution of Civil Engineers, and will be familiar to most of our readers.

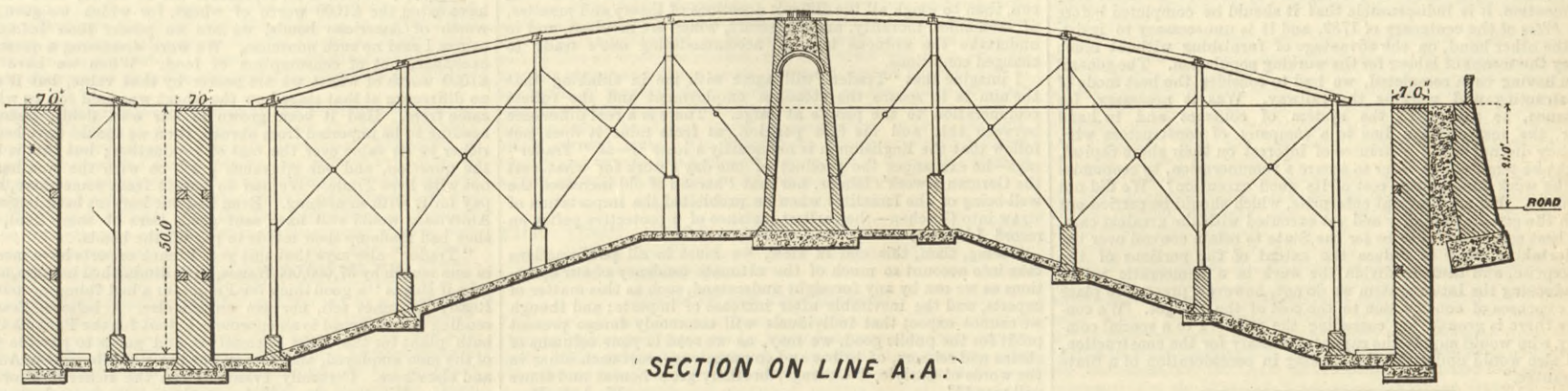
Among the machinery exhibits may be mentioned as specially noticeable a large collection of ploughs, reapers, and binders, by Messrs. J. and F. Howard; steam threshing machinery, by Messrs. Clayton and Shuttleworth; and corn mills, by Messrs. E. R. and F. Turner.

The greater portion of the Exhibition comprised articles which do not come within the province of this paper, and our readers will be able to see many of them for themselves, as we understand the best exhibits are being sent home for the Colonial Exhibition. The Exhibition was formally opened on December 10th, 1885, by Sir Hercules R. Robinson, the Governor of the Cape Colony, and the total attendance during the Exhibition was upwards of 60,000.

Royal Institution of Great Britain. — At the general monthly meeting on Monday, April 5th, 1886, the Duke of Northumberland, K.G., President, in the chair, John Wolfe Barry, M. Inst. C.E., Sir Thomas Brassey, K.C.B., M.P., Mr. Arthur Carpmael, Mr. Ernest Carpmael, Mr. Allan Harvey Drummond, Mr. Edmund Macrory, Mr. William Hugh Spottiswoode, were elected members of the Royal Institution. Eight candidates for membership were proposed for election.

THE BIRMINGHAM GASWORKS.—240ft. GAS HOLDER TANKS.

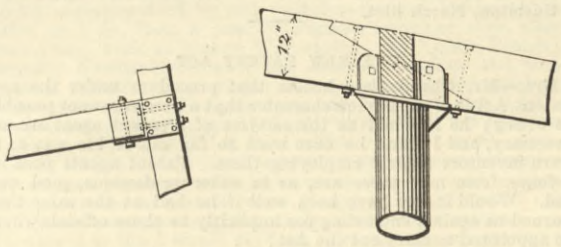




SECTION ON LINE A.A.

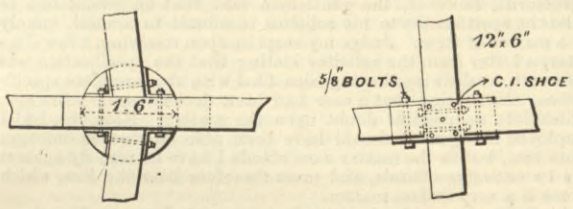
THE LARGEST GASHOLDER TANKS IN THE WORLD.

We publish this week an illustration of two gasholder tanks recently constructed from the designs, and under the superintendence of Mr. Charles Hunt, M. Inst. C.E., for the Corporation of Birmingham, at their Windsor-street Gasworks. They are the largest in existence, being 240ft. in diameter and 51ft. deep, and are separated from each other by a wall 7ft. in thickness. They are constructed wholly of bricks, and made watertight with cement rendering, a ½in. coating of Portland cement and washed sand being first applied, and finished off with ¼in. of



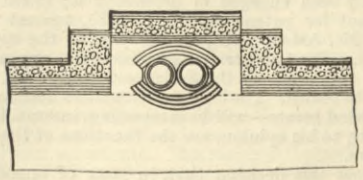
TIMBER FRAMING CONNECTIONS.

neat cement. The substitution of this for clay puddle as usually employed is estimated to have effected a saving in the work of nearly £6000. In consequence of the peculiar nature of the soil, which is a drift deposit, consisting of pure sand, sand and



TIMBER FRAMING CONNECTIONS.

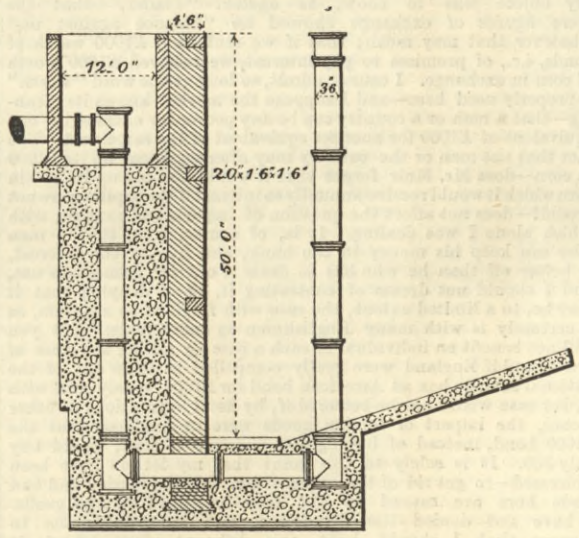
loam, with fine drift coal, the work proved to be one of exceptional difficulty, it being found impossible to effectually drain the site. For the latter purpose three pumps had to be em-



DRAIN FROM WELL.

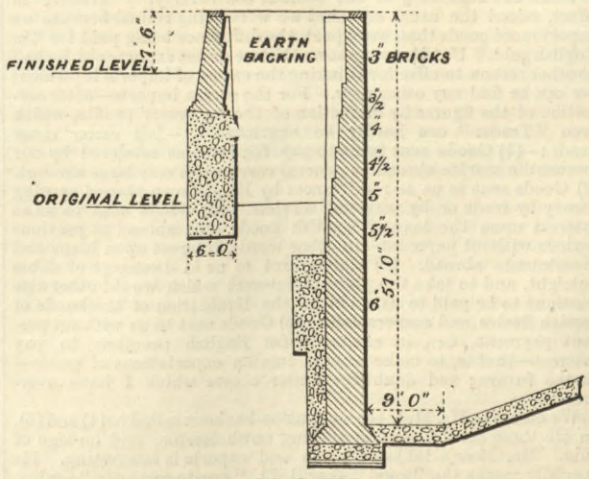
ployed, two of them reaching down to the new red sandstone, which on the very edge of the site occurs within 59ft. 6in. from the surface of the ground, or 85ft. 6in. below coping level of tanks, but is nowhere else attainable at any practicable depth. The united pumping from these pumps brought to the surface about 3,000,000 gallons of water daily, the water being kept down to a level of 87ft. 8in. below coping level of tanks. In addition to

SECTION THROUGH WELL



these, several donkey and hand pumps had to be kept continually going in different parts of the trenches ; but in spite of

SECTION ON LINE B.B.



SECTION OF OUTER WALLS.

all efforts, the work was much of it almost under water, and the bottom for the most part a mass of slurry. It became necessary to form an artificial foundation for the walls, which was done by excavating a further depth of 2ft. 6in. in short lengths, covering the bottom with two thicknesses of 3in. elm planking, and filling in on the top of these with 2ft. deep of Portland cement concrete. In addition to this, sheet piling had to be resorted to for keeping back the slurry and preventing it from rising up underneath the foundations. 9in. by 3in. and 9in. by 4in. deals were driven in close together on each side of the trench for a depth of 9ft. ; but, in spite of all precautions, the work was continually being disturbed by bursts of water, bringing up large large quantities of silt. In many portions of the trench the slurry had to be baled into the skips, and rose almost as fast as it was removed. Continual settlements of the timber took place, the frames often sinking as much as 3in. per day ; and timbermen had to be employed night and day, jacking up and strutting with raking-struts the most troublesome portions. Inside the tanks the soil was just as bad and difficult to work. Much trouble was experienced through the slipping of the cones, the loamy clay possessing very little cohesion—in consequence of which they had to be made much lower than was originally intended, and with a flatter slope. The timber frames for supporting the crowns of gasholders when the latter are out of action are carried upon cast iron columns resting upon brickwork piers. Some idea of the magnitude of the work, which cannot be gathered from our engravings, may be gathered from the fact that the cement rendering covers an area of about 20,000 square yards, or a little over four acres. The contractors were Messrs. J. Aird and Sons, Belvedere-road, Lambeth.

The gasholders placed in these tanks, which have recently been completed, and which we hope shortly to illustrate, are likewise the largest in existence, having a united capacity of upwards of 13,000,000 cubic feet.

A METROPOLITAN RAILWAY FOR PARIS.

Although there seems to be some discrepancy in the figures, the following, from the Paris correspondent of the *Times*, is of much interest :—

"The Government laid before the Chamber yesterday the Paris Metropolitan Railway Bill, and the provisional agreement entered into between the Minister of Public Works and M. Albert Christophle, the Governor of the Crédit Foncier. The capital of the company will be 50,000,000f. The management will be entrusted to a board of twelve members, eight selected by the shareholders, and four named by the Government, which has reserved two of these seats to the Municipal Council of Paris. Alongside of this board, and representing alike the interests of the shareholders, the Government, and the City of Paris, there will be a governor named by the State, who will have a right of veto, in this respect resembling the organisation of the Bank of France. The objects kept in view in the plan are the easy conveyance of passengers and goods, the direct communication of despatches to the General Post-office, and the union of the great lines of railway. The plan comprises (1) an inner circle line along which the rails will pass according to the nature of the ground traversed, underground through cuttings or over viaducts ; (2) two great arteries destined to connect the stations of the great companies and intersecting Paris. One underground will connect the Gare de l'Est, pass through the district of the General Post-office and Halles, and terminate at Mont Parnasse station ; the other, which will be above the surface level, will connect with each other (1) the St. Lazare and the Nord stations by a line which will pass through the Carrefour Drouot ; (2) the two stations so united of the west and north with the Vincennes and Lyons stations by means of a line passing from the Carrefour Drouot and leading towards the Avenue Daumesnil by crossing the district of the Halles, which, serving as a point of

intersection of the above-ground artery and the underground artery, will thus have exceptional advantages. The contemplated stations number sixty-four, of which twenty-eight are to be on the viaduct, fifteen over open cuttings, and twenty-one over the underground way. The Government intend to divide the various works just referred to into two series. The first series will include those which can be completed before 1889—that is to say, the circles, the underground artery, and the Union line of the western and northern stations through the Carrefour Drouot. The second series will include the construction of the overground artery which is to connect the Carrefour Drouot with the Vincennes station. The division of these two series will correspond very closely to the equal division of the total expense. The Minister of Public Works has considered it prudent to begin with those operations which are sure to be completed before the exhibition. On the other hand, the construction of the central artery will make several changes necessary in the direction of streets and roads to be carried out by the city, and it has therefore been thought wise to give the municipality time to study and prepare for them. It is estimated that the works constructed, the cost of property acquired, interest, and, in short, the total expense, will amount to from 450,000,000f. to 475,000,000f. Of this total the first series of works, that is to say the construction of the underground artery, the circular line, and the union of the western and northern stations, will require 225,000,000f. The above-ground artery alone will absorb the rest, the appropriation of property in the heart of Paris making the establishment of this central line very costly. The State gives a guarantee of 4 per cent. on the total expense; but it believes that by an arrangement it has made it has considerably diminished the burden of this guarantee. In compensation for the increased income brought to the great railway companies by the junction of their lines, they will become responsible to the State for a subsidy of 7,000,000f., and they undertake that this guarantee shall come into operation in proportion as the construction of the lines is proceeded with. In this way they guarantee 5,000,000f. after the first series of works, the other 2,000,000f. being required after the construction of the central artery. It follows that, the State guaranteeing 9,000,000f. of interest to the 225,000,000f. of estimated expenses, and the subsidy of the great companies providing 5,000,000f., the engagement of the Treasury will be finally reduced to 4,000,000f., which may be reduced to a smaller figure if the traffic proves as great as it is maintained it will by the authors of the various schemes."

"The question of a Metropolitan Railway, solved in London, Berlin, and New York, has remained a problem for a long period of years in Paris. Its solution is required, and cannot be long delayed. Without speaking of the permanent necessities which would be provided for by the new means of communication, it is indispensable that it should be completed before the *Fêtes* of the centenary of 1789, and it is unnecessary to insist, on the other hand, on the advantage of furnishing without much delay the means of labour for the working population. The general plan having been completed, we had to consider the best mode of constructing and working the railway. Was it necessary, for instance, to return to the system of contract and to hand over the metropolitan line to a company of constructors who, if they did not ask a guarantee of interest on their share capital, might be tempted, in order to secure a remuneration, to economise on the work done at the cost of its good execution? We did not think so. For such a great enterprise, which should be carried out with the greatest rapidity and yet executed with the greatest care, the best course seems to be for the State to retain control over the undertaking, and to reduce the extent of the portions of the enterprise, and thus to divide the work in a democratic spirit. In adopting the latter system we do not, however, propose to place the expenses of construction to the cost of the Budget. We consider there is ground for conceding the network to a special company who would supply the capital necessary for the construction, and also would undertake the working in consideration of a State guarantee."

THE INSTITUTION OF NAVAL ARCHITECTS.

The following programme for the session of 1886 has just been issued. The meetings will be held in the Hall of the Society of Arts, John-street, Adelphi. On Wednesday, April 14th, morning at 12 o'clock; on Thursday, April 15th, morning at 12, and evening at 7 o'clock; on Friday, April 16th, morning at 12, and evening at 7 o'clock. The Right Honourable the Earl of Ravensworth, President of the Institution, will occupy the chair.

Wednesday, April 14th, morning meeting at 12 o'clock:—(1) Annual Report of Council; (2) Election of officers and the Council; (3) Address by the President. The following papers will then be read and discussed:—(1) "On the Speed Trials of recent War Ships," by Mr. W. H. White, Director of Naval Construction, Member of Council. (2) "On an Improved Mechanical Method of finding the stability of a Vessel," by Mr. J. H. Heck, Member. (3) "A Strain Indicator for use at Sea," by Mr. C. E. Stromeyer, Member.

Thursday, April 15th, morning meeting at 12 o'clock:—(1) "A brief Review of the Progress of Mild Steel, and the Result of Eight Years' Experience of its Use for Shipbuilding Purposes," by Mr. B. Martell, Chief Surveyor to Lloyd's Register of British and Foreign Shipping, Member of Council. (2) "The Present Aspect of Mild Steel for Shipbuilding," by Mr. John Ward, Member. (3) "On the Use of Steel Castings in lieu of Iron Forgings and Brass Castings," by Mr. E. C. Warren, Member.

Thursday, April 15th, evening meeting at 7 o'clock:—(1) "Closed Stoke-holes," by Mr. R. Sennett, Chief Engineer, Inspector of Machinery, Admiralty, Member of Council. (2) "On Forced Combustion in Furnaces of Steam Boilers," by Mr. James Howden, Member. (3) "On Modern Improvements in the Working of Cables and the Stowage of Anchors," by Mr. S. Baxter, Member.

Friday, April 16th, morning meeting at 12 o'clock:—(1) "Experience in Propulsion with Three Screws," by M. M. Marchal, Member. (2) "The Determination of the most suitable Dimensions for Screw Propellers," by Mr. R. E. Froude, Associate Member of Council. (3) "Account of an Instrument intended to Register the Rolling of Ships," Vice-Admiral E. Paris, Honorary Associate. (4)* "Proposed Steam Life-boat with special reference to its Stability," by Mr. L. Benjamin, Member, and Mr. J. M. H. Taylor, Associate.

Friday, April 16th, evening meeting at 7 o'clock:—(1) "On Converting existing Compound Engines into Triple Expansion Engines," by Mr. H. A. B. Cole, Member. (2) "Flexible Crank and Screw Shafting in lieu of Rigid Shafting for Marine Propulsion," by Mr. J. F. Hall, Member. (3)* "On a New System of Steering Gear and Rudder Strains recorded by it," by Mr. A. J. Maginnis, Member.

Papers marked * will be read and discussed if there is time; if not they will be taken as read and published in the "Transactions."

City and Guilds of London Institute.—A special course of lectures on "Steam Boilers" will be given at Finsbury Technical College, Leonard-street, City-road, by Professor John Perry, M.E., F.R.S., every Thursday evening during the summer term, from 7 to 8, commencing on Thursday, April 15th. (1) Construction of the Lancashire boiler; The nature of combustion; The testing of fuels; Conditions necessary for good combustion in boilers. (2) The way in which heat is given to the water; Efficiency of the furnace and heating surface; Chimney and mechanical draught. (3) Strength of boilers; Strength of the shell and flues; Positions and strengths of stays; Rivetted joints. (4) Constructive details; Stresses due to unequal expansions and contractions. (5) The fittings of boilers. (6) Forms of modern boilers and general comparisons in regard to efficiency, strength, life, and suitability to circumstances. Fee for the course 5s. Apprentices admitted at half the ordinary fees.

LETTERS TO THE EDITOR.

(*Continued from page* 279.)

FREE TRADE AND NO TRADE.

Sir,—If "X." really imagines that the excess of import values represents the world's annual increase of wealth, and is a fact of the same order with the increase of the rateable value of Middlesex, he is hardly likely to be competent to understand the answer to his question, though given by the most competent authority. One might as well contemn the elements of geometry, and ask to be told in plain terms the truth about the stress diagram controversy which rages in a neighbouring column. As to our trade with Germany, I can give him a crumb of consolation; the German returns value imports and exports alike at £25,000,000.

"Trader," on the other hand, is on the verge of making for himself the discovery which was one of the brightest achievements of the father of political economy, namely, the surpassing importance of the home trade. But he must remember that a vast number of our population are dependent upon the existing fabric of trade, and any rash disturbance of its course will but intensify the present distress.

Fair Traders and socialists alike justly criticise the current political economy. But all the errors of the old school centre round one central fallacy—the assumption that the selfish pursuit of individual interests will unrestrained produce the greatest well-being in the community. The germ of it is to be found in Adam Smith, though he constantly refutes it in detail, the perfection in the saying attributed to Mr. Bright, that adulteration is a necessary incident of competition. The practical outcome is that trade is regarded as essentially gambling, in which whatever one gains another loses, and commercial intercourse between nations is regarded as a species of warfare. The fact is that the commercial economy of the day has broken down because of its dishonesty. Protection is an impossibility at present in England. It did us no good when we had it, by all accounts I ever read. There is no proof that it does good in France to-day. It does not stop imports; for in the last ten years the imports of manufactured goods into France have increased 80 per cent., and allowing for the gross profit—not net profit, as "Trader" supposed; see account of earnings of one coal steamer given in Engineer three weeks back—of our carrying trade, the French imports bear about the same relation to exports that ours do, and if there is any truth in the newspaper reports it does not prevent distress, one year with another very near the present distress in England. The fact is, it is so much easier when one feels the pinch to cry out for a tax which might make one's own fortune—I know perfectly well what I want taxed!—but could not benefit the nation in the long run, than to weigh all the difficult questions of theory and practice, of economics, morality, and statecraft, which are involved, and to undertake the arduous task of accommodating one's trade to changed conditions.

I imagine that "Trader" will agree with me in thinking that the aim is to secure the steadiest employment and the fullest remuneration to the people at large. There is a real difference between this and his first position, as from mine it does not follow that the Englishman is necessarily a loser if—as "Trader" says—he exchanges the product of one day's work for what cost the German a week's labour, nor that Pharoah of old increased the well-being of the Israelites when he prohibited the importation of straw into Goschen—the earliest instance of a protective policy on record, I believe.

Having, then, this end in view, we must in all public actions take into account so much of the ultimate tendency of our operations as we can by any foresight understand, such as this matter of exports, and the inevitable after increase of imports; and though we cannot expect that individuals will commonly forego present profit for the public good, we may, as we read in your columns of chains and scissors, of bribes and commissions, greet each other in the words of Carlyle, "Courage, brother, grow honest and times will mend!" W. A. S. B.

Kensington, March 27th.

Sir,—Mr. Muir in his letter of the 19th of March is hardly just to me. He does not controvert any argument I put forward with regard to the export of foreign securities. My object was to show, as against "Trader," that the mere figures of exchange showed no "balance against us," whatever that may mean; that if we sent away £1000 worth of bonds, *i.e.*, of promises to pay interest, we received £1000 worth of corn in exchange. I cannot admit, so long as the word "worth" is properly used here—and I suppose the market knows its meaning—that a man or a country can be any poorer for exchanging one equivalent of £1000 for another equivalent of the same sum. The fact that the man or the country may afterwards eat up its £1000 in corn—does Mr. Muir forget that it would also eat up its £50 in corn which it would receive annually as interest if the capital were not repaid?—does not affect the question of imports and exports, with which alone I was dealing. It is, of course, true, that a man who can keep his money in the bank, and live on the interest, is better off than he who has to draw it out for immediate use, and I should not dream of contesting it, or of denying that it may be, to a limited extent, the case with England as a nation, as it certainly is with many Englishmen as individuals. But you will not benefit an individual in such a case by raising the price of bread, and if England were really compelled to draw out of the national savings box an American bond for £1000, to buy corn with it, her case would not be bettered if, by fiscal regulations or other means, the import of foreign goods were so hindered that the £1000 bond, instead of buying 600 quarters of corn, would buy only 300. It is solely to this point that my letters have been addressed—to get rid of the superstition that depression and bad trade here are caused by the free import of foreign goods. I have not denied the depression, and have no reason to suppose that I should hold any different views about it from Mr. Muir, whose letter evinces a great deal of knowledge of the subject. It urgently demands the fullest and most thoughtful treatment by men who can write like Mr. Muir and "W. A. S. B.;" but they should insist, as I have done, that mere fallacy-mongers be cleared out of the way first. It seems necessary to recall the beginning of the tedious controversy. "Trader," in effect, raised the usual cry that we were being ruined because we import more goods than we export, the difference being paid for "in English gold." Until he was shown that we do not export gold, he had no other reason to offer for thinking the excess of imports injurious; nor can he find any other now. For the excess imports—after correction of the figures by deduction of the importers' profits, which even "Trader" can hardly be aggrieved by—fall under these heads:—(1) Goods sent to us to pay for services rendered by our mercantile marine abroad as general carriers—a very large amount. (2) Goods sent to us as remittances by Englishmen abroad earning money by trade or by personal services. (3) Goods sent to us as interest upon the loan of English goods sent abroad at previous periods without payment—in other words, interest upon loans and investments abroad. (4) Goods sent to us in discharge of debts outright, and to take the place of interest which would otherwise continue to be paid to us, such as the liquidation of the bonds of foreign States and corporations. (5) Goods sent to us without present payment, *i.e.*, in exchange for English promises to pay interest—that is, to make annual smaller exportations of goods—in the future; and doubtless under others which I have overlooked.

We owe it to Mr. Muir that attention has been called to (4) and (5). In all these cases I can see nothing unwholesome, and no sign of ruin. Mr. Muir's table of years and exports is interesting. He specially marks the "good" year, 1871, "great prosperity"—when the excess of imports was only 11 per cent. But why? Because it was the time of great foreign loans. We can always have great exports on those terms—that is, on condition that we will send goods abroad without asking present payment. But experience, drawn from the "good" years, makes capitalists more shy than they were of embarking in such investments, for some of the loans of those days have been repudiated; at least interest is not transmitted. Was it really good for us, then, that we sent abroad goods which were not paid for at the time, and for which interest is not paid now? Is that the way to enrich a country? Apparently Fair-Traders think so; for they are never tired of glorifying the years of great exports, and never stop to inquire whether those exports were paid for. If every one of the foreign loans and investments which those goods represented had been repudiated immediately, Fair-Traders would still, I suppose, point to the years of great export as those of prosperity. I am aware that the subsequent payment or non-payment for the goods would but little affect the workmen who made them, and who, of course, received their wages week by week; but at present we are talking of the effect upon the wealth of the nation at large. On the other hand, suppose the interest on all these foreign loans had been, and was still being, paid punctually. In that case our imports would be larger than they are now, and the excess would be greater. We should be receiving our dues instead of losing them; yet, according to the Fair-Traders, we should be worse off—*ipso facto*.

There is plenty to discuss; but it must be after this sort of thing is brushed away, or discussion to be useful should be limited to those who can understand that great exports do not necessarily mean addition to the national wealth, and can clear their minds of the fallacy that imports can be artificially limited without limiting exports as well. Mr. Muir's table begins with 1860, and an excess of imports of 28 per cent., "generally prosperous," and ends with 1885, and an excess of 32 per cent.—or nearly the same—and "bad all round;" so this percentage is not the key to the question. But many still think so, and "X."—26th March—demands, with an air of easy triumph, that I should say how the £78,000,000 of imports from certain countries, to which we exported only £33,000,000, were paid for. So far as it admits of answer—considering that it is useless to select particular countries only, owing to the Clearing House kind of action between our various debtors and creditors, well pointed out by one of your correspondents—"X.'s" question has been abundantly answered, and I cannot go over the ground again. I will only remark in passing that "X.'s" second paragraph is very doubtful political economy. The world grows richer, not by what it sells and exchanges, but by what it makes or grows, and finds a good use for. The all-round excess of imports over exports measures nothing but the profit of certain individuals—the importers. I fail to see that it gives even the remotest clue to the general increase of the wealth of the world. A country which had neither imports nor exports might increase in wealth as rapidly as one which acted as mart for the world.

"Trader," March 19th, represents me as saying that when we have eaten the £1000 worth of wheat, for which we gave £1000 worth of American bonds, we are no poorer than before. Of course I said no such nonsense. We were discussing a question of exchange, not of consumption of food. When we have eaten £1000 worth of wheat we are poorer by that value, but it makes no difference at that stage how the wheat was paid for, or where it came from. Had it been grown in our own fields, instead of needing to be imported from abroad, then we should have been the richer by its value over the cost of production; but that is beside the question, and our grievance must be with the weather, and not with Free Trade. We had to buy it from somewhere, and to pay for it with something. Even had our harvest been larger, the Americans would still have sent goods here of some kind, since they had made up their minds to pay off the bonds.

"Trader" also says that this year French exports have increased in one month by 37,000,000 francs, with diminished imports, and he asks if this is "a good thing for France, or a bad thing, or neither." Really I cannot tell, nor can anyone else. I believe France is sending goods abroad to an enormous extent for the Panama Canal, both plant for the works themselves, and goods to pay the wages of the men employed, and to pay for the plant bought in America and elsewhere. Certainly France is not the richer now for these exports. Whether she will be so ultimately depends upon the return which the Panama Canal may yield. No better illustration of the questions between us could be found than this case of present French exports. He who runs may read it, even Fair-Traders, I hope.

I venture to think the questions of excess of imports as a cause of trade depression, and the advantage to be derived from artificially limiting it—so that foreigners shall be forbidden to pay us what they owe us, or to send us the wherewithal to pay for the goods they would like to buy from us—have now been fairly well thrashed out, and I beg to withdraw from it, though not unwilling to join in again if those much deeper questions which Mr. Muir raises can be discussed without the intrusion of fallacies on which ink is but wasted. Those questions may lead us to deeper depths than Fair-Traders wot of. Mark H. Robinson.

Surbiton, March 31st.

THE NEW PATENT ACT.

Sir,—Mr. Chamberlain boasts that procedure under the new Patent Act is of so simple a character that a person cannot possibly go wrong; he has told us the services of a patent agent are unnecessary, and I think he once went so far out of his way as to warn inventors against employing them. Patent agents need no defence from me; there are, as in other professions, good and bad. Would it not have been well if he had at the same time warned us against entrusting too implicitly to those officials whom he appointed to carry out the Act?

Some time back I received a letter from the Patent-office, signed J. Clark-Hall, informing me that I might use the drawings lodged with my provisional specification to illustrate the description in the complete specification. In full reliance on the correctness of this, I drew up my complete specification accordingly. Having been fortunate enough to find a capitalist to take up my patent, I hoped I was at the end of my difficulties. Before signing the agreement, however, the gentleman said that he would like to take the specification to his solicitor to submit to counsel, merely as a matter of form. Judge my surprise upon receiving, a few days later, a letter from the solicitor stating that the specification was informal, no drawings having been filed with the complete specification, also stating that a case had been decided some years ago, which left no possible doubt upon the matter. Now, Sir, had I employed an agent I should have been able to recover damages from him, but as the matter now stands I have no remedy against the Patent-office officials, and must therefore bear the loss, which to me is a very serious matter.

April 6th. An Inventor of Limited Means.

Sir,—As there is no official publication of proceedings before the Comptroller, or before the law officers on appeal, any information respecting such proceedings must be of interest to many readers of your journal.

I have lately been engaged in defending my client, Mr. C. W. Jones, applicant for patent No. 5237, 1885, against proceedings conducted by Mr. Aston, Q.C., on the part of the opponent, Mr. E. J. J. Dixon. The Comptroller's decision was appealed against, but has been supported by the Solicitor-General, and the patent will therefore be sealed. The Solicitor-General's decision—extracts of which I append hereto—will be interesting, inasmuch as it states what, according to his opinion, are the functions of the law officers in such matters.

I gather from this decision that, in cases of opposition to the grant of letters patent, "on the ground that the invention has been patented in this country on an application of prior date," it will be well not to appeal to the law officers during the continuance of the present Solicitor-General in office, if the Comptroller decides on allowing a patent to be sealed. It is clear that the law officer will not reverse the decision of the Comptroller, unless there is identity of description in the specification relied upon by the oppo-

ition and that of the applicant; and in such cases the Comptroller would naturally not decide on allowing a patent to be sealed.

In any case where the Comptroller decides in favour of the opponent, and there is not absolute identity of invention according to the conflicting specifications, the applicant may appeal to the law officers with the greatest confidence. This being so, Sub-section 4, Section 11 of the Patent Act, 1883, providing for the law officer obtaining the assistance of an expert, will surely remain inoperative.

It seems to me that after a final specification has been officially accepted in accordance with Section 9 of the Patent Act, that Act does not vest in the Comptroller any power to require any amendment; but in my case an amendment (*sic*) has been ordered in the shape of a disclaimer of that which has neither been described nor claimed, and the law officer will not interfere with the Comptroller's decision. There is no further appeal, so I can only submit, and hope for the day to arrive when the law officer will not allow a patent to be sealed, saying that he does not give any opinion as to whether or not the alleged invention to be sealed is a colourable imitation of the invention forming the basis of the proceedings of opposition. H. Moy Thomas.

Canonbury-place London, March 24th.

C. W. Jones' application for Patent No. 5237, 1885, *and E. J. J. Dixon's opposition thereto.—Appeal to Law Officer.*

Extracts from the Solicitor-General's decision, dated March 22*nd*, 1886.

"I should observe that it is not for me to say whether the third claim of Dixon's patent is proper subject matter for a patent, or whether Jones' alleged invention is proper subject matter, or even whether Jones' method of fastening the frames of slates is or is not a colourable imitation of Dixon's. I have no jurisdiction to do so. . . . I will not interfere with the Comptroller's decision requiring words to be inserted disclaiming Dixon's patent.

"H. Moy Thomas, Patent Agent,
Canonbury-place, London."

COMPOUND LOCOMOTIVES.

Sir,—I have read with much interest the correspondence, and examined the illustrations, which have appeared in your paper from time to time with reference to "Compound Locomotives," and regret to say that, in my opinion, some of the most eminent locomotive engineers of the present day have entirely failed in approaching the real system of compounding locomotives, and appear to have ignored the proper principles which constitute a compound engine. All the so-called compound engines which have been illustrated recently have had the same fault, that is, no proper provision for the free escape of the exhaust steam in passing from one cylinder to the other, and the difficulty in starting has not yet been overcome, although additional valves, auxiliary ports, &c., have been supplemented. I think it is now generally admitted that up to the present time the compound locomotive is a complete failure.

Having had considerable experience in the above-named engines, I contend that a pair of compound cylinders should either work simultaneously together or in opposite directions. Therefore, in designing a locomotive I should prefer two pairs of cylinders, to economise room; the low-pressure cylinders might be cast together and placed inside the framing, which would be connected to the crank axle in the ordinary way, the two high-pressure cylinders would be connected to outside cranks on the driving wheels, each pair of cylinders working at right angles to each other, but working simultaneously together, the admission of steam to be effectde by one double slide valve to each pair of cylinders, and to be on the top of the high-pressure cylinder and worked by a cross shaft and levers in the usual way, and with one excentric if necessary. By this arrangement the strain on the crank part of the axle would be considerably reduced, the motion would be more uniform and the starting force would be greater than in any ordinary engine; there need only be a small portion of lap on the steam port of the valve and none on the exhaust side, then the engine would start in any position of the cranks and with more energy than an engine with an early cut off.

I am satisfied that an engine could be constructed on my plan at less cost, would be less complicated, more durable, and much more economical than any of the so-called compound engines of which we have heard so much about lately. Practical.

April 6th.

THE EDUCATION OF ENGINEERS.

Sir,—I shall be glad if you will afford me a small space in your journal for some remarks on your article respecting the Engineering Tripos at Cambridge. No one would be more inclined than I to agree with you on the question of the undesirability of theoretical training unaccompanied by real workshop practice, looking at the matter, as I do, from a practical engineer's point of view, after fifteen years' work at Messrs. Whitworth's, the Vulcan Foundry Company, Newton-le-Willows, the Ashbury Carriage and Iron Company, and other large works; but with other of your opinions I cannot quite agree. The points you raise briefly amount to this; Theory at Cambridge is a good thing for an engineer, but as it can only be got at the expense of time which would be more advantageously used in a large works, a young man will be no forwarder in his engineering career when he leaves us than he would be when entering a works at sixteen years of age, and that he could not possibly be a competent engineer as the result of our training.

In answer to this I would say that a young man on entering a works does not get, as a matter of fact, any theoretical training whatever. He is turned into the shops, and picks up as much as he can of the use of the tools and of fitting; but it is no one's particular duty to teach him even this part of his work, and the larger the works in which he finds himself the less will he be looked after. His mathematics on leaving school at sixteen consist of arithmetic, algebra so far as quadratics, and perhaps the merest smattering of plane trigonometry. Would you be satisfied with this amount of mathematics? I may assume not, for you say that during his five years' pupilage he will improve his knowledge up to the required standard. Now, Sir, this can hardly be. How can a young man learn statics, dynamics, hydrostatics, differential and integral calculus, solid geometry, easy differential equations, and rigid dynamics—which we here in Cambridge think an engineer ought to know—when the whole of his day is spent in the shops or the drawing-office? I am satisfied that this kind of hard reading cannot be done at night satisfactorily after a day's physical work. Then, again, is any young man just out of his articles a competent engineer? My contention is that he would be much more competent to take charge of work if he had been with us for five years than he would be had he spent the same time in a works, for he would have done with us a considerable amount of theory at the same time that he was acquiring practical experience in the shops, and, as a consequence, the latter would be better grasped, and make a greater impression on him. I think, however, that on this point you would be more inclined to agree with me if you saw the work which was done here. For instance, during the last two years three 1000-candle power dynamos, four heavy double-geared 6in. lathes, ten 5in. lathes single and double-geared, 18in. circular saw benches, morticing machine, small dynamos, half a dozen 2-horse engines, a 12in. shaping machine, and various other works have been wholly or partly completed. We cast about half a ton every week during term, and a large quantity of brass and gun-metal work is also turned out. This surely is "practical" training, and it has this great merit over that in a works, viz., that a pupil fits up the whole of one job himself, whereas in a works he is kept to fitting blocks in links, or fitting up rod ends, or some one job, until he is sick of it, and he learns nothing for at least half of the time. If a man on leaving us finds he has to take "the lowest place," it is not because he is not competent to take a higher one, but because of the prejudice of employers. It is inevitable that men should think the way in which they and their forefathers were trained was the best one, and time alone will convince them that there is a more excellent way. I am one of those who look on the first five years of a young engineer's life as time which must be spent in laying a good foundation on which to build his future experience, and not as a period in which he "learns his trade," and I am content to leave time to demonstrate that this can be done better in the Engineering Department of the Cambridge University than in the workshops of the world.

March 25th. James Lyon, M.A., Superintendent.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, March 27th.

The striking spirit extends throughout the United States, and as fast as one set of difficulties is disposed of, as many more arise. Agitations will likely disappear by April 1st, as the advances asked for are generally paid. The Board of Directors of the Missouri Pacific Railway Company held a session in this city yesterday, and endorsed the course of the Governor of Missouri in calling out the State militia. The people of Missouri, Kansas, and the South-west, have been greatly inconvenienced by the suspension of traffic, and material of all kinds is scarce along several lines and branches. Public meetings are being held in the interest of one side or the other. The industrial situation has not improved since last week. A large amount of work will be placed in the manufacturing establishments along the Atlantic coast, but employers and manufacturers are unwilling to hasten business, as long as it is uncertain as to the cost of labour or the duration of the working day. Several large contracts have been recently cancelled, one for the construction of two iron ferry boats, to cost a quarter of a million. Several negotiations amounting to 100,000 dols. and over are declared off until the interested parties can see a little further. According to our best local authority, 20,000 men returned to work during the past week, and during the next week or two nearly all of the remaining strikers will be at work. Iron and steel brokers report a falling off in inquiry for material, and stock brokers predict a further decline in railway stocks on all lines excepting those under the control of Jay Gould and the Vanderbilts. Stocks of this character are being purchased by those interests as fast as they are thrown upon the market. No difficulty is encountered in obtaining money on loans for industrial and railway enterprises. Three or four important schemes have just been presented to New York financiers for the construction of about 800 miles between the Atlantic and the Mississippi, during the six months beginning May 1st. A large amount of railway material will be ordered in a short time. The trunk lines have placed orders for freight cars, and the New Jersey Locomotive Works have just secured large locomotive orders for roads in the South. It is generally believed that with the settlement of the strikes a large amount of business will be thrown upon the market, and that there will be a reaction towards higher and firmer prices. A great deal of business now in the hands of manufacturers is being done at less profit than last year even under higher prices, because of the fact that so much of the business in hand was taken at prices from 10 to 15 per cent. below current rates. The bituminous strike involving between twenty and twenty-five thousand men is still in force, and there is a great scarcity of soft coal in New England markets.

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

(*From our own Correspondent.*)

The quarterly meetings have been held this week. The amount of business transacted has been of a limited character in every department, while prices have been of an unsatisfactory nature. The attendances at the gatherings have been good, iron and steel masters and merchants and consumers coming from all parts of the kingdom; but there has been little spirit in the transactions. Orders in the ensuing two or three weeks, alike on export and on home account, should, however, show up better as the result of the inquiries made at the gatherings.

Although £7 10s. has been re-declared by the marked bar houses, yet these same firms continue to offer with great freedom a second quality iron at £6 10s., and even £6 5s. per ton. It is only by adopting this course that they can succeed in getting enough orders to keep the mills even partially employed.

The Earl of Dudley's list for the new quarter stands at:—Flats, rounds, and squares, lowest quality, £8 2s. 6d.; single best, £9 10s.; double best, £11; treble best, £13. His lordship's rivet and T-iron is £10 10s. for single best; £12 for double best; and £14 for treble best. Lowest quality T-iron is £9 2s. 6d. Angles, strips, and hoops from 14 to 19 w.g. are £8 12s. 6d., £10, £11 10s., and £13 10s., according to quality. Strips and hoops, $\frac{7}{8}$in. of 20 gauge, are £9 12s. 6d., £11, £12 10s., and £14 10s.; while for $\frac{3}{4}$in. a further 20s. per ton is demanded on each quality.

The list of John Bagnall and Sons is: Bars, 1in. to 6in., £7 10s.; 6½in. to 9in. flat bars, and 3½in. to 4in. round bars, £8; 4½in. to 4¾in., £8 10s.; 4⅝in. and 4½in., £9; 4⅝in. and 4¾in., £9 10s.; 4⅞in. and 5in., £10. As to rounds only, the large sizes are: 5¼in. and 5½in., £10 10s.; 5⅝in. to 5¾in., £11; 5⅝in. and 5¾in., £11 10s.; 5⅞in. and 6in., £12; 6¼in. and 6½in., £13. Hoops and angles are quoted £8, and rivet iron £9 to £10 according to quality. Sheet quotations are: 20 g., £9; 24 g., £10 10s.; and 27 g., £12.; but these quotations are hardly more than nominal. Boiler plates are £9, £10, £11, and £12, according to quality.

Messrs. Noah Hingley and Sons quote rounds and squares ½in. to 3½in., and flat bars 1in. to 6in.—Netherton Crown best and Netherton Crown best horseshoe, £7 10s.; best rivet iron, £8; double best plating and double best Crown bars, £8 10s.; and treble best Crown, £9 10s. Netherton Crown best angles are £8, and tees £8 10s.

Common bars show a drop of between 2s. 6d. and 5s. upon the quarter, and were selling yesterday in Wolverhampton at £4 15s. to £5 per ton, while ordinary bars were £5 10s. to £6. Common hoops were abundant at £5 to £5 5s., and gas tube strip was selling at £4 17s. 6d. to £5 2s. 6d.

The sheet trade was not active, though some makers were able to report that their works are still making full time. In such cases firm prices were asked, but with the majority of the market, prices showed a reduction on the quarter of 5s. to 10s. per ton. Doubles for galvanising purposes were freely offered at £6 5s., and some makers did not refuse £6, while 27 gauge were £7 to £7 5s. Galvanisers' orders in the black sheet trade may be expected to improve before very long, but at present the success of the galvanisers upon the coast in taking orders which formerly fell to this district makes materially against activity at the black sheet works.

The demand for best thin sheets is considerable on account of the Australias, Canada, the United States, and certain of the continental countries. Quotations keep at £10 to £11 for working-up qualities, and £11 to £12 for stamping sorts, but in actual business lower prices are allowed to rule.

Steel was offered at this week's gatherings in great variety, and at prices which must be regarded as tempting. There was plenty of competition between the various districts for orders, and it is almost difficult to imagine how makers can get a profit upon some of the business transacted. Bessemer blooms made by West Coast and Welsh firms are quoted £4 15s. delivered here, and billets at £4 10s. upwards. Welsh plating bars are £5 to £5 5s. delivered here. It is gratifying that the stoppage of industry which threatened at the works of the Staffordshire Steel and Ingot Iron Company has been overcome by the men in the Bessemer and in the rolling department having now consented to accept the 10 per cent. reduction. The works are now, therefore, running as usual.

The steel works of the Lilleshall Company, Shropshire, are well engaged, and the orders upon the books insure employment for the next few months. The company is not now, therefore, careful to book much new business, hoping prices may show up better when present contracts are in execution.

The pig iron trade does not show increased vitality, and the contracts placed this week have not been for large lines. The Lilleshall Company at Wolverhampton yesterday quoted cold blast pigs Nos. 1, 2, and 3 at 75s., 80s., and 85s. per ton respectively. Hot blast pigs of Shropshire and Staffordshire make were quoted 52s. 6d. to 55s., but business is being done in some instances at 50s.—a drop on the quarter of 2s. 6d. per ton. Native part-mines were very varied. The Spring Vale make of pigs was quoted—best hydrates, 50s.; mine, 42s. 6d.; and common, 32s. 6d. per ton. The Willingsworth make of part-mine was quoted 35s., while Bradley's Darlaston make was quoted 41s. for No. 1 foundry and 37s. 6d. for forge made of Northampton ores. Consumers of medium and common pigs generally stated that they had little difficulty in placing orders of much size at quite 1s. 3d. per ton below the market quotations. Common pigs might, indeed, have been bought plentifully at 30s. per ton—a drop on the quarter of fully 2s. 6d. per ton.

There has been some discussion this week concerning the suggestions of the British Iron Trade Association for a national restriction in the make of pig iron, but while being of opinion that such a course would be very desirable if it could be arranged, the majority of the makers express but little belief in its possibility.

Coal was in supply largely in excess of demand, and the Cannock Chase colliery owners have come to an arrangement to play two whole days a week, with the object of keeping down the supply. Forge coal varies from 5s. to 6s. per ton; mill coal, 6s. to 7s.; and furnace coal, 7s. to 8s., and occasionally 9s.

At Birmingham this—Thursday—afternoon all Wolverhampton prices were fully confirmed, but the business transacted was small. Hematites were quoted 52s. 6d. to 53s.; Welsh tin-plates, 12s. 6d. to 13s. per box; charcoals, 16s.; good demand. John Knight and Co., of Cookley, have now started their new tin-plate and best sheet works at Brierley-hill. Steel rails of 80 lb. section were understood as now being down to £4 5s. instead of £4 15s., as formerly, and other sections were reduced in similar ratio. To-day a big order for steel sleepers has been placed with two steel firms outside this district by one of the London railway companies, who have determined to adopt metal sleepers. As a result of the Belgian strikes, English sheet-glass makers have just raised prices 17½ per cent.

At a quarterly meeting at Stoke-on-Trent on Monday of the members of the North Staffordshire Coal and Iron-Masters' Association, the reports given in as to the state of the trades showed no improvement whatever with regard to prices. The home trade continues very quiet, but hopes are entertained that there may shortly be a revival in the demand for the colonies and some foreign ports.

Constructive engineers note with satisfaction that inquiries continue to make their appearance upon the market from the Indian railway companies. The Indian Midland Railway Company desires a supply of steel work and ironwork for bridges of 10ft. to 45ft. clear span; the Southern India Railway Company is requiring 200 tons of iron bridge-work, as also railway switches and crossings; and the Southern Mahratta Company desires switches, railway fastenings, &c.

The old-established and much reputed firm of Messrs. T. Perry and Son, Highfield Works, Bilston, has been formed into a private limited liability company, and will henceforth be carried on as T. Perry and Son, Limited.

Considerable interest is felt here in the reply on Monday in the House of Commons of Mr. Mundella to the question put to him by Mr. Alfred Hickman, one of the members for Wolverhampton, concerning the issuing of fraudulent test certificates in the chain cable trade. Some disappointment is felt that Mr. Mundella should have been able to promise nothing more definite than that he will instruct the Board of Trade to be very careful to attend to the provisions of the Acts as at present existing. Regret is expressed that the Board of Trade should have no power to concern themselves with the manufacture of chains or chain cables for home or foreign buyers to whom the Acts do not apply, and who do not desire to have the security of the public tests.

The revelations of the frauds in the cable trade induce one to look with some suspicion on any example of defective working of these goods. On Tuesday a large steam crane was at work on the new premises of the Staffordshire Joint Stock Bank, Birmingham, when the chain of the ponderous piece of mechanism snapped, and the jib, together with a stone weighing about a ton which was being raised, descended with a crash on the unfinished structure. Fortunately the jib was arrested in its descent by the scaffolding, and no one was injured.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—"Flat, stale, and unprofitable" is now a very much quoted phrase with regard to the condition of the iron trade in this district, but it scarcely expresses the real situation. The year, after three months of the worst trade that has been known for the past forty years, has now entered upon the second quarter with no sign of improvement, and the outlook for the future is despondent in the extreme. Notwithstanding the recent advance in Scotch warrants, business is only practicable where sellers are prepared to take the lowest prices that have been ruling of late, and then it is only for very small quantities, in most instances, that orders are given out. Even the persistent efforts which are being made to bring about a restriction of the output are regarded with indifference, and the downward tendency of Scotch warrants during the past week indicates a want of confidence in any successful movement in this direction. The general belief is that many of the makers are in such a position that they are compelled either to keep their furnaces going or stop altogether; and although no one questions the fact that the present supplies of pig iron are far in excess, not only of current requirements, but of any immediately prospective wants, there are so many conflicting interests involved that an artificial restriction of the output extending over a sufficiently wide area to be really effective is surrounded by difficulties that are well-nigh insurmountable. The "survival of the fittest" would seem to be the only possible issue out of the present struggle for existence, and the probability of a low range of prices continuing for some time to come will have to be faced by improvements and economies in the methods of production which will leave makers some margin for profit upon the low basis of values.

There was again only a very quiet iron market at Manchester on Tuesday, and only a small inquiry for any description either of pig or finished iron. Users of pig iron have no urgent wants of any moment, and although iron is offered to them at prices which under ordinary circumstances would be readily accepted, it is only in exceptional cases that they are induced to buy beyond their hand-to-mouth requirements. Occasionally, where deliveries extending over the remainder of the year can be obtained at the present low rates, an order for a moderate weight of iron is given out; but the general attitude of consumers is that having no work in prospect to justify large purchases of iron, they are averse to entering into anything like speculative transactions, however tempting the prices which sellers are prepared to accept. For Lancashire pig iron the average prices for delivery equal to Manchester remain at about 37s. 6d. to 38s., less 2½ per cent., and the better class of district brands are quoted at from 37s. to 38s. 6d., less 2½ per cent., for forge and foundry qualities delivered here; these figures, however, bring forward very little business in the face of the much lower prices at which some Lincolnshire brands continue to be offered, sellers of these being open to accept about 36s. to 37s., less 2½ per cent., for forge and foundry delivered into this district. In outside brands the tendency of prices has been downwards, and for both Scotch and Middlesbrough brands makers' prices are very little above the rates ruling prior to the recent advance in Glasgow warrants.

There is still an absence of inquiry for hematites, and prices are extremely low, 51s. to 51s. 6d., less 2½, being about the average figures for good qualities of No. 3 foundry delivered into this district.

Some of the forge proprietors in this district report that they are not quite so badly off for work as they have been recently, but in the market there is no perceptible improvement in the demand, buyers during the past week having rather been holding back pending the result of the quarterly meetings, and prices are quite as low as ever. Delivered into the Manchester district, bars remain at about £5 per ton, hoops at £5 7s. 6d., and local-made sheets at about £6 10s. per ton.

All branches of the ironfoundry trade are in an extremely depressed condition, with prices cut excessively low to secure orders. This is especially the case in heavy castings for constructive work, and cast iron columns delivered into this district can be got at under £5 per ton, with cast iron girders quoted at about £4 10s. per ton. In rolled and rivetted plate girders the Belgian makers continue to compete here at prices which cannot be touched by the English makers. Belgian rolled iron girders are being delivered into this district at £4 15s. per ton, which is fully 5s. per ton under the price asked by English makers, whilst rivetted plate girders of Belgian make are to be got here at £6 5s. per ton, as against £7 10s. per ton asked for English rivetted girders. In pipe castings prices are being cut extremely low. For ordinary sections about £4 4s. per ton is quoted for delivery into this district, but orders of any weight could be placed at very little over £4 per ton.

The condition of the engineering trades generally remains without improvement. It is true that some firms are busy on Government and special work, and that here and there amongst machine tool makers there appears to be a more hopeful tone; but the reports received through the authoritative channels of the employer's organisations continue very unsatisfactory.

In connection with the strikes, which have assumed such serious proportions in America, the following extract from a private letter received from an English workman in Ohio, who has special opportunities for forming a correct judgment as to the situation, will be of interest. The writer says:—"We are having a lively time over here in the matter of strikes. They have become so numerous that they have become momentous, and some of them are ill-advised, and for that reason dangerous. Labour has for the last few years been so estranged that some have lost sight of everything but revenge. A change for the better having presented itself, advantage has been taken of the fact, and an almost general demand for an advance of wages with a reduction of hours has been the result. In many cases the demand was instantly complied with, and, as a consequence, a feeling of triumph has pervaded all branches, and has led many to think that any demand, no matter how unreasonable, would be conceded at once. Many demands of the latter nature have been made, and I fear the result may be disastrous unless an immediate halt is called."

Throughout the coal trade there is a generally quiet demand as regards all descriptions of fuel. For house fire coals requirements have fallen off considerably since the commencement of the month, but in these there is still a fair business doing as compared with other classes of fuel. Common round coals are extremely bad to sell, owing to the continued depression in nearly all manufacturing branches of industry, and there is so great a drug of supplies in the market that to clear away stocks prices have to be cut excessively low. For this branch of trade the prospects are as gloomy as they possibly can be, and the railway companies believe that they will be able to renew their contracts for locomotive fuel at even lower prices than were taken last year. Engine classes of fuel are also plentiful in the market, and bad to sell, the depression in the salt and chemical trades having thrown large quantities of this class of fuel upon the market, and sales are pushed at very low figures. In prices there is a tendency to give way, although not to the extent of what may be termed a general reduction. Where, however, concessions are absolutely necessary to effect sales, there is a little easing-down to meet buyers, to the extent here and there of 3d. per ton on house fire coals, and in some instances 6d. per ton on common round coals. At the pit mouth the average quoted figures are about 8s. 6d. to 9s. for best coals, 7s. to 7s. 6d. seconds, 5s. to 5s. 6d. common coals, 4s. to 4s. 6d. burgy, 3s. to 3s. 6d. ordinary qualities of slack, with some best sorts fetching 3s. 9d. to 4s. per ton.

It is very exceptional where more than a moderate business is reported for shipment, and steam coals are offered for delivery at the High Level, Liverpool, or the Garston Docks, at extremely low figures; the better qualities are not to be got at under 7s. per ton, but inferior sorts are to be bought without difficulty at 6s. 9d. per ton.

The proposed prohibition of the employment of women on the pit banks is raising a very strong feeling throughout the mining districts of Lancashire, and the Mining Association is taking energetic measures to oppose this and other matters, as it is felt that the legislative interference with the management of collieries is being carried to such an extreme as to be quite intolerable. So far as the colliery women themselves are concerned, there is no desire to be relieved of this means of employment, which is by no means of an exceptionally arduous character, and certainly not more arduous than many other classes of labour to which women have to resort.

Barrow.—Business in the hematite pig iron trade has been exceedingly quiet during the past week or two, and the hesitancy with which buyers have placed orders for some time is still very marked. The cause of this has already been explained in my previous reports. Now that the Steel Railmakers' Association has been dissolved, and the members have determined to wind up its affairs at once, the members are at liberty to offer deliveries in the open market without any tie in any way in reference to the Association. This being the case, enquiries are beginning to be made by those who for some time have held aloof from purchases in the hope that prices would decline, and that they would be able to buy more cheaply in the open market. The value of pig iron, however, still remains very steady, at 42s. 6d. per ton net at makers' works, prompt delivery for mixed parcels of Nos. 1, 2, and 3 Bessemer, and 41s. for No. 3 foundry and forge iron. In the latter descriptions trade remains exceptionally quiet, inasmuch as very little of this description of pig iron is now used. Makers are for the most part employed on orders placed some time ago for forward delivery, but these are beginning to run out, and it is evident that if the orders anticipated by the dissolution of the protective association above alluded to do not soon come to hand, some of the furnaces now making iron will have to be blown out, and the production of the district thus reduced. Makers of steel have reduced their quotations for foreign steel this week by 2s. 6d. per ton, and it is expected that within a very few days some heavy contracts will be booked for Canadian railways. The stocks of iron on hand are quite as large as they have been. Shipbuilders have booked no new contracts, and they have failed to secure any of those orders which they have of late been contracting for. Iron ore is still difficult to sell. Some new mining enterprise is being pushed at Gutterly, in Cumberland. Coal and coke are in restricted consumption. Shipping quiet, and few outward cargoes are offering.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

At the last meeting of the Sheffield Chamber of Commerce, the president reported the result of the deputation to Mr. Mundella on the subject of false marking. The whole subject was fully discussed. It was pointed out that, in order to obtain full protection abroad, it was necessary that we should place ourselves in a position to afford to foreigners as well as natives similar protection in this country. The result of the interview was that Mr. Mundella announced his readiness to accredit the Master Cutler and Mr. Hughes, the secretary to the Chamber of Commerce, as assistants to the British delegates at the International Convention at Rome, and the Cutlers' Company was requested by Mr. Mundella to lay the whole of their views upon the subject of false marking before the Board of Trade in the shape of suggestions for a Bill to be submitted to Parliament. This suggestion was shortly afterwards carried into effect by the Cutlers' Company. Mr. Charles Belk, the Master Cutler, communicating with the president of the Chamber of Commerce, stated:—"I feel convinced that at last the principle for which the Cutlers' Company has long and earnestly striven in regard to the marking of goods will be presented before the International Convention for the Protection of Industrial Property not merely as an expression of the views of the Cutlers' Company, but as an object of importance enough to carry with it the influence of the British Government." I understand that the suggestions for the necessary home legislation are already under the consideration of the Board of Trade, but that before their adoption they will be submitted to the consideration of the different industries affected, not only in Sheffield, but in the country at large.

Sheffield is keenly interested in commercial intercourse with Spain. A well-known Sheffield manufacturer, Mr. John Bedford—Messrs. Jno. Bedford and Sons—has been co-operating with a body of gentlemen at Birmingham with a view to organising a large and influential deputation to Lord Rosebery upon the necessity of obtaining "most-favoured nation treatment" for Great Britain in Spain. Lord Rosebery has declined to receive a deputation on the ground that the time is inopportune, but invited a statement of the British case to be laid before him. Mr. Bedford has handed in a copy of that statement, and it has been cordially adopted by the Sheffield Chamber of Commerce, who have passed a resolution energetically supporting the endeavours of Mr. Bedford and his colleagues at Birmingham and elsewhere, in their endeavours to secure just treatment for British commerce in Spain "through the medium of her Majesty's Secretary of State for Foreign Affairs."

A gentleman in Paris has called attention to a fraudulent practice, which he states is carried on to a large extent. It is that of importing German electro-plate and cutlery into Paris and then removing from such goods the German labels and replacing them by English labels identifying them with Sheffield. The Master-Cutler and Mr. Hughes, who have been appointed to represent Sheffield at the Industrial Convention, have decided to have an interview with the gentleman and inquire into the matter with the view of thoroughly investigating this new phase of the false marking business.

Though the electric light comes slowly into use, it is moving in this district. I hear that a company has been formed to supply it to householders in Sheffield, and at the festivities to be held this month at Clumber in honour of the coming of age of the Duke of Newcastle, the large temporary buildings to be erected for the accommodation of the tenantry and others will be lighted by electricity.

Local iron and coal trades continue unaltered. Common pig is weak in price, best foundry selling in some instances at less than 40s. at the works, while forge pigs are at 33s. at the works. In manufactured iron high qualities are unaltered; ordinary sorts vary in price. Wages disputes are becoming uncomfortably frequent, as employers, in their anxiety to keep the markets, try to reduce production by enforcing lower conditions of labour. House coal is selling more slowly owing to the milder weather, and in some quarters values are weaker. Steam coal and manufacturing fuel are both languid.

In some of the heavy industries, notably in armour plates, gun forgings, and marine forgings, as well as heavy castings, there is a satisfactory business doing; but the lighter industries keep very quiet, particularly in the grades of cutlery, edge tools, files, saws, and plated ware, which have to contend with German competition. The only orders of any consequence in the silver trade I have heard of since last week was one for a London establishment, taken by Messrs. W. and G. Sissons, of St. Mary's-road, the value of which is £2000. In the cutlery and hardware trades the men are only partially employed, and there is a good deal of distress among the artisans in these crafts.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

There was little to distinguish the quarterly meeting of the Cleveland iron trade, which took place at Middlesbrough on Tuesday last, from an ordinary weekly market. The attendance was scanty, and business was far from brisk. The better feeling noticeable during the early portion of last week has now completely disappeared, owing to the reduction in prices which has taken place at Glasgow. Makers and merchants appear to have so far succeeded in maintaining the higher rates which were established last week, but buyers are extremely shy, and purchase little. For prompt delivery of No. 3 g.m.b. merchants quote 30s. 3d. per ton, for delivery over next month their price is 30s. 6d., and for the second half of the year they ask 31s. to 31s. 6d. Some makers will accept 30s. 6d. per ton for No. 3 for immediate delivery, but the principal firms quote 3d. to 6d. more. None of them are anxious to commit themselves far into the future at present.

Warrants are firm at 31s. per ton.

The stock in Messrs. Connal and Co.'s Middlesbrough store was on Monday last 211,738 tons, which is equivalent to an increase of 1951 tons during the week. At Glasgow their stock is now 721,137 tons, representing a further increase of 6913 tons.

Finished iron manufacturers are no better off. Fresh inquiries are few, and the competition for orders is exceedingly keen. There is no alteration in quotations.

Messrs. Raylton, Dixon, and Co., of Middlesbrough, have received an order for a large steamer for a Hull firm.

Messrs. W. Gray and Co., of Hartlepool, are building a steamer for the petroleum trade. She will be capable of carrying about 2000 tons of oil. Instead of being fitted with tanks, as is usual, the shell of the vessel will be used to form one side of the compartments. The electric light will be fitted throughout, in order to avoid the danger of naked flames. The petroleum will be discharged by two of Worthington's pumping engines, of a size and power supposed to do the whole work in twelve hours.

The average net selling price of Northumberland coal for the months of December, January, and February was 4s. 7·21d. per ton. This will not involve any alteration in wages.

The workmen employed at Messrs. Bolckow, Vaughan, and Co.'s foundries and engineering works at Middlesbrough have received fourteen days' notice to terminate their engagements. About 500 men are affected. It is thought that this step is preliminary to the enforcement of a reduction of wages.

The last meeting but one for the session of the Cleveland Institution of Engineers was held at Middlesbrough on Monday evening last. The paper read was one by Mr. Theodore West, of Darlington, on "An Outline History of the Locomotive Engine in America," being a sequel to the paper on the "History of the Locomotive in England," read by the same author at the previous meeting. There was a large attendance, the subject, and Mr. West's lucid treatment of it, having excited great interest in the district. The paper was illustrated by outline drawings of each successive type of locomotive, these drawings having been lithographed on a small scale and arranged in sheets for use at the meeting and for subsequent reference. Mr. West stated in his introduction that his own lifetime was nearly coincident with the period during which the locomotive had been developed, and it had been mostly passed at Darlington and Leeds, industrial centres which might be considered nurseries of engineering. He had also had opportunities of visiting America and the British colonies and studying its history there. When it became known he was preparing a paper on the subject numbers of engineers, old engine drivers, and other railway men came forward and assisted him with information in their possession not hitherto made public, so that he was able to do justice to the subject in a way otherwise impossible. A few years longer, and many of these witnesses might be gone beyond recall. Certainly Mr. West's paper, with the illustrations accompanying it, is more complete and interesting than anything of the kind hitherto published, and it will form a valuable addition to the printed "Proceedings" of the Cleveland Institution. An animated discussion ensued, in the course of which further information relating to the subject was elicited and duly recorded. A hearty vote of thanks to Mr. West concluded the proceedings.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The Glasgow warrant market, which was depressed after the failures of last week, recovered considerably, in consequence of the meeting of ironmasters held in London with the view of arranging for a general reduction of output throughout the United Kingdom. The position of the Scotch pig iron trade at present is the reverse of satisfactory. The past week's shipments, coastwise and abroad, amounted to only 5655 tons, as compared with 6013 in the preceding week and 7525 in the corresponding week of 1885. When it is stated that the week's imports of Cleveland pigs into Scotland are greater than the whole of the shipments of Scotch pigs, it will not be necessary to say anything further regarding the depressed condition of the trade. The output is practically unchanged in amount. Stocks continue to increase, the past week's addition in Messrs. Connal and Co.'s stores being 6876 tons.

Business was done in the warrant market on Friday at 39s. 9d. per ton. On Monday transactions occurred at 39s. 9½d. to 39s. cash. Tuesday's business was done from 39s. 0½d. to 39s. 3d., returning to 39s. 1d., and closing at 39s. 2d. cash.

The current values of makers' pig iron are as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 44s.; No. 3, 42s.; Coltness, 48s. and 43s. 6d.; Langloan, 44s. 6d. and 43s.; Summerlee, 47s. 6d. and 42s. 6d.; Calder, 47s. and 41s. 6d.; Carnbroe, 44s. and 41s.; Clyde, 43s. 6d. and 40s. 6d.; Monkland, 40s. and 37s. 6d.; Quarter, 40s. and 36s.6d.; Govan, at Broomielaw, 40s. and 37s. 6d.; Shotts, at Leith, 45s. 6d. and 45s.; Carron, at Grangemouth, 48s. 6d. and 45s. 6d.; Kinneil, at Bo'ness, 43s. 6d. and 42s. 6d.; Glengarnock, at Ardrossan, 43s. 6d. and 41s.; Eglinton, 40s. and 37s.; Dalmellington, 41s. 6d. and 39s.

The inventory of the personal estate of the late Robert Donaldson, senior partner of the firm of James Watson and Co., iron merchants, Glasgow and Middlesbrough, has been returned at £522,388 4s. 4d.

In the past week there was shipped from Glasgow five locomotive engines, valued at £12,500, for Bombay; machinery, £5100; sewing machines, £2011; steel goods, £7400; and general iron manufactures, £15,000, including £4150 worth of sheets, bars, plates, and tubes for Bombay.

The coal trade has been quiet in the course of the week, and the shipping demand has not yet developed to the extent that was anticipated. The past week's shipments are accordingly barely satisfactory. From Glasgow, the quantity despatched was 24,425 tons, as compared with 26,334 in the same week of last year; Greenock, 347 against 1245 tons; Ayr, 7602 against 7820; Troon, 7521 against 5853; Leith, 1598 against 670; Grangemouth, 7336 against 8754 tons. The household and manufacturing inquiry is quiet, and steam coals are only in limited request.

The statistics of her Majesty's Inspectors of Mines for Scotland show that while the output of coals in the United Kingdom has been smaller in 1885 by 1,406,361 tons than in the preceding year, the production in Scotland was 21,288,586 tons, or an increase of 139,546 tons over that of 1884. Except for a strike that occurred in one of the steam coal districts at the very dullest season of the year, when there was scarcely any inquiry for that class of coals, the miners worked steadily throughout the year; and although their wages were low, there was much less distress among the mining population than in towns of higher pay and frequent labour disputes. In the case of the coalmasters the year was an unprofitable one generally, although the turnover in most departments was extensive

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

If I state that the coal trade has fallen off a good third I am not out of bounds. Take last week for example, as regards Cardiff foreign exports, and the falling off is fully one-third. It was 50,000 tons less last week than the week preceding, and the question asked by coalowners and shippers is, "Where is this to end?"

A matter of discussion, too, at the ports of Swansea and Newport in particular, is how far the adaptation of engines, vertical and horizontal, locomotive and stationary, for oil instead of coal fuels, will further depreciate coal. I am told that gas engines are making good headway in works.

The best collieries are not working half-time, and some large ones one or two days a week at the most. Prices, too, are low. A few days ago a cargo of best steam was sold by auction at Cardiff, and the price reached was only a shade above 5s. per ton.

Steam coal, I am told, is now being put on board for 8s. 6d. to 8s. 9d. This would mean a trifle less than 6s. 6d. or 6s. 9d. at the pit's mouth. All collieries are suffering in proportion, and the zest in trying to get hold of the little trade, bunker and otherwise, that is moving about, is remarkable. The ironworks collieries are no better off than the rest, and the collection of laden wagons on colliery sidings, and at Roath siding, Taff Vale, on Saturday, was greater than I have known.

Pitwood is slightly better, and prices have touched 15s. again.

In the midst of existing depression, the only briskness perceptible is in connection with the Barry Docks and railway. Mr. Walker is making good headway, and the directors, in visiting docks, laying the foundations, putting in the centres of bridges, and travelling on the new line as far as practicable, seem confident of their undertaking; 20,000 cubic yards of material were removed from the dock last week alone.

Mr. Mackay, of Hereford, well known locally, is the contractor of the line from Treforest to Hafod. It seems almost farcical to announce coal "finds" in the present day, when coal is so depressed, yet there was some jubilance at Aberghorkey, Rhondda, this week on the 9ft. seam being struck after several months' operations. If trade revives this will employ many additional hands.

The colliery enginemen at Tylorstown, who struck against the reduction, have resumed work. In several districts the enginemen and stokers have consented, and the rest will doubtless follow. A meeting of the South Wales Colliers' Association was held on Saturday last at Cardiff, Mr. A. Hood in the chair, and the meeting decided that the 2½ per cent. reduction to enginemen must be enforced. Their average earnings are 18s. a week.

The cloud that seemed gathering over the Swansea tin-plate trade is clearing. The reduction of 10s. in steel compelled the owners of forges to follow with a similar reduction, and this, as I stated last week, was resisted. Now owners and men seem to take a more reasonable view, and an equitable compromise is being arranged. Prices remain firm at last week's quotations:—Cokes, 13s. 6d. to 14s.; Bessemer, 13s. 9d. to 14s. 3d.; Siemens, 14s. 6d.; charcoals, from 15s. 6d. to 17s. Bessemer is tolerably good.

The joint Rhymney and Great Western line was opened into Merthyr, April 1st, and promises to do well.

I have not a line of encouragement for the iron and steel works. Quietness prevails, and the wages earned are very small. A moderate import of pig from Middlesbrough into Swansea, a small bar trade with France, and some few home and colonial rail orders dispersed amongst the various works represent the Welsh iron trade.

NEW COMPANIES.

The following companies have just been registered:—

Spiel's Patent Petroleum Engine Company, Limited.

On the 26th ult. this company was registered with a capital of £100,000, in £5 shares, to acquire the letters patent No. 4008, dated 18th August, 1883, and No. 3414, dated 17th March, 1885, granted for improvements in petroleum and gas engines, the inventions of Johannes Spiel, of Berlin. The purchase is subject to an unregistered contract of the 22nd ult. between Wm. Robt. Crozier and C. H. Haynes. No particulars are given in the memorandum and articles of association as to the consideration for the purchase of the patents, and as to the special arrangements made with the promoters. The subscribers are:—

	Shares.
*D. W. Forbes, Smithfield Works, Blackwall, engineer	1
*S. Wilkinson, Snowdon, Leyton, engineer	1
*W. Bramham, Albion Works, Bow-road, engineer	1
*W. Eames, 150, Leadenhall-street, engineer	1
*J. Dunsmore, West Ferry-road, Millwall, engineer	1
*P. J. Ogle, Swansea, engineer	1
C. Holland Haynes, 49, Warwick-road, Earl's-court, secretary to a company	1

The number of directors is not to be less than three nor more than nine; qualification, 40 shares; the first are the subscribers denoted by an asterisk. The remuneration of the board will be at the rate of £200 per annum for the chairman, and £100 per annum to each ordinary director, and by way of additional remuneration, whenever 15 per cent. dividend is paid, 5 per cent. per annum upon the net profits.

Turpin's Parquet Floor, Joinery, and Wood-Carving Company, Limited.

This company was registered on the 27th ult. with a capital of £30,000, in £5 shares, to take over the business of parquet floor manufacturing and modelling carried on by Marie Firmin Charles Turpin at 22, Queen's-road, Bayswater, and elsewhere. The subscribers are:—

	Shares.
J. M. MacLaren, 3, Duke-street, Adelphi, architect	1
V. Large, 48, Gower-street, manager of a wine business	1
M. Rosenberg, 13, Norfolk-terrace, Bayswater, decorator	1
*G. A. Williams, 21, Queen's-road, Bayswater, window-blind manufacturer	1
A. G. Williams, 21, Queen's road, Bayswater, window-blind manufacturer	1
*M. F. C. Turpin, 22, Queen's road, Bayswater, parquet floor manufacturer	1
C. E. Randall, 5, Upper Spring-street, Baker-street, bookkeeper	1

The number of directors is not to be less than two nor more than five; qualification, £250 in shares; the first are the subscribers denoted by an asterisk, and Mr. R. Coad; remuneration, £200 per annum.

Cool Air Drying Company, Limited.

This company proposes to purchase upon terms of an agreement of the 16th ult. a cool air drying business, with patent rights, plant, machinery, &c., belonging thereto. It was incorporated on the 31st ult. with a capital of £30,000, in £5 shares. The subscribers are:—

	Shares.
*A. W. Money, Liss, Hants	400
*T. P. Hilder, 8, Draper's-gardens, stock and share dealer	200
*H. J. Nevill, 45, Charles-street, Berkeley-square	200
Paul Ewen, 87, Shirland-gardens, Maida Vale	5
E. J. Neale, Westgate House, Bedford Park, law student	1
Lieut. L. Gye, Naval and Military Club	1
A. D'Arcy Bannerman, 9, Woodland's-road, Barnes, secretary of a company	1

The number of directors is not to be less than three nor more than seven; qualification, fifty shares; remuneration, £600 per annum. The first three subscribers and Lieut.-Col. F. G. Hill are the first directors.

Sherman Iron and Steel Treating Company, Limited.

This company was registered on the 31st ult. with a capital of £100,000, in £10 shares, to treat, purify, and manufacture iron and other ores and metals, and to carry on business as ironmasters, colliery proprietors, and engineers. The subscribers are:—

	Shares.
W. Powter, 21, Gotha-street, South Hackney, clerk	1
C. J. Berdel, 28, Gracechurch street, merchant	1
H. W. Sams, 16, Hollydale-road, Peckham, clerk	1
C. Buckland, 8, Chadwick-road, Peckham, journalist	1
H. F. Easton, 8, Peak-hill, Sydenham, clerk	1
A. Cohen, 49, Buckingham-place, Brighton, journalist	1
J. W. Clark, 7, Clifton-square, Peckham	1

The number of directors is not to be less than nine. The above signatories are empowered to appoint the first directors, to fix the qualification, and to determine the remuneration of the board. These gentlemen are also to appoint the first solicitor and secretary, and may determine the remuneration of the latter. The board may appoint a general manager and fix his remuneration.

Anthropological Institute of Great Britain and Ireland.

This society was incorporated on the 26th ult. as a company, limited by guarantee to £1 each member—the word "limited" being omitted from the title by the Board of Trade licence—to promote the study of the science of man. The subscribers are:—

W. W. Flower, British Museum, director of the Natural History Department.
F. M. Rudler, 28, Jermyn-street, curator, Museum of Practical Geology.
R. Meldola, Finsbury Technical College, professor of chemistry.
R. B. Martin, Chislehurst, banker.
F. G. Hilton Price, Temple-bar, banker.
J. G. Garson, M.D., Charing-cross Medical School.
E. W. Brabrook, 28, Abingdon-street, barrister.

The government of the institute will be vested in a president, vice-presidents, secretary, treasurer, and a council of twenty members.

Thomas Perry and Son, Limited.

This company was registered on the 30th ult. with a capital of £85,000, in £100 shares, to acquire the goodwill of the business of engineer, ironfounder, manufacturer of bedsteads, safes, &c., carried on at Highfield, near Bilston, Stafford, by Thomas Perry and Son. The subscribers are:—

	Shares.
*F. C. Perry, Penkridge	1
Miss J. M. Perry, Wolverhampton	1
Miss Helen Perry, Wolverhampton	1
Mrs. H. E. Perry, Penkridge	1
*H. H. Fowler, Wolverhampton, solicitor	1
T. C. Broad, Wolverhampton	1
F. T. Langley, Wolverhampton, solicitor	1

The subscribers denoted by an asterisk are the first directors; remuneration, £600 per annum. Mr. James Smith is appointed managing director at a salary of £250 per annum.

R. and H. Green, Limited.

This is the conversion to a company of the business of R. and H. Green, of Blackwall, and the city of London, shipbuilders, makers of caissons, pontoons, &c. It was registered on the 25th ult. with a capital of £150,000, in £50 shares. An agreement of the 18th ult. regulates the purchase, the consideration being £138,000 in fully-paid shares. The subscribers are:—

	Shares.
*Hy. Green, Blackwall, shipbuilder	86
*J. F. Green, Blackwall, shipbuilder	35
*C. E. Green, 13, Fenchurch-avenue, shipbroker	53
*F. Green, 13, Fenchurch-avenue, shipbroker	1
*T. L. Delvitt, 13, Fenchurch-avenue, shipowner	20
*J. Bell, 13, Fenchurch-avenue, shipbroker	20
F. Stokes, 21, Great St. Helens, solicitor	1

The number of directors is not to be less than three nor more than seven; qualification, 20 shares; the first are the subscribers denoted by an asterisk. The company in general meeting will determine the remuneration of the board.

Penmon Quarries, Limited.

This company proposes to acquire and work certain quarries situate in the parish of Penmon, Anglesea, known as the Bulkeley Park and Deer Park Quarries. It was registered on the 27th ult. with a capital of £50,000, in £1 shares, 35,000 of which are 10 per cent. preference shares. The subscribers are:—

	Shares.
A. Harlow, 24, Bingfield-street, Caledonian-road, financier	1
George Shelley, 91, Talfourd-road, Peckham, advertisement contractor	1
W. B. Hodgson, 59, Ilderton-road, S.E., clerk	1
A. G. Jeakins, 9, Charles-street, Walworth, clerk	1
D. C. Laughton, 94, Petherton-road, N., advertisement contractor	1
H. Moore, 150, Sewardstone-road, E.	1
J. Evans, 4, Creed-lane, Ludgate-hill, clerk	1

The number of directors is not to be less than three nor more than seven; qualification, 250 shares; the first are Messrs. Roderick Macdonald, M.P., J. E. Vincent, and T. H. North. The remuneration of the board will be determined at the first ordinary general meeting.

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.

30th March, 1886.

4416. Pencil Holder, S. W. Wood, London.
4417. Fastening the Ends of Rim Bands, J. Wagstaff, Halifax.
4418. Knitted Fabrics, G. F. Sturgess and J. Hearth, Leicester.
4419. Trouser Stretchers, J. Cadbury and J. G. Rollason, Birmingham.
4420. Stoppers for Bottles, B. Harrison, Oldham.
4421. Portable Tubulous Kettle, &c., M. Bousfield, York.
4422. Lubricating Leather, W. A. Entwistle and P. Smith, Manchester.
4423. Securing Sticks, &c., to Brooms. E. R. Baller, Shirley.
4424. Bakers' Ovens and Hot Plates, W. Cook, Glasgow.
4425. Oxanite Engine, W. F. Bower and G. F. Down, London.
4426. Petroleum Engines, W. F. Bower & G. F. Down, London.
4427. Numbering, &c., Tickets, &c., J. M. Black, London.
4428. Metallic Boxes for Oil, &c., F. M. E. Pizey, London.
4429. Heater for Boilers, L. A. Groth.—(*A. Traub, France.*)
4430. Furnace Grate, L. A. Groth.—(*A. E. Barthel, United States.*)
4431. Covered Wires, A. J. Boult.—(*W. M. Habirshaw, United States.*)
4432. Devices, &c., for Smoking Tobacco, J. Byron, London.
4433. Engineers' Instruments, C. G. Smith and E. and C. H. Warren, London.
4434. Apparatus for Cleaning Windows, &c, C. Gall, Halifax.
4435. Plough and Sash Fillister Plane, W. G. Rowe, London.
4436. Stones for Polishing, G. McPherson, jun., Glasgow.
4437. Hammerless Guns and Rifles, J. W. Smallman, London.
4438. Music, &c., Stands, J. E. Palmer, London.
4439. Ventilator, J. A. Sharp, London.
4440. Packing Rings for Pistons, W. Laing, London.
4441. Napkin Rings, W. J. and F. A. Chatwin, London.
4442. Dress Shields, H. J. Haddan.—(*R. Hicks, United States.*)
4443. Automatic Railway Signals, E. D. Dougherty, London.
4444. Speed Indicators, H. Herden, London.
4445. Crates, J. C. Chapman, London.
4446. Breech-loading Fire-arms, B. J. B. Mills.—(*G. D. Potter, United States.*)
4447. Springs for Self-closing Doors, R. Adams, London.
4448. Drill Chuck or Holder, D. Gillies, jun., London.
4449. Pencil Attachments, J. W. Milligan.—(*E. Weissenborn, United States.*)
4450. Shelling Maize, N. Clayton and A. Shuttleworth.—(*G. R. Brown, Buenos Ayres.*)
4451. Fastenings for Retort Lids, G. King, Essex.
4452. Crayon Holder, J. Y. Johnson.—(*The Eagle Pencil Company, United States.*)
4453. Electrical Cells, M. Bailey and J. Warner, London.
4454. Portable Electric Light, W. E. Moser, London.
4455. Butter-workers, T. Bradford, London.
4456. Christmas, &c., Cards, A. Tuck, London.
4457. Suspender for Curtains, H. F. Patten, London.
4458. Coupling for Rolling Stock, W. A. Burrows, London.
4459. Incandescent or Glow Lamps, R. C. Hanrott, London.
4460. Gas Engines, H. T. Dawson, London.
4461. Stourbridge Fire Lump Bridges, G. A. Trotter, E. S. Haines, and W. Corbett, London.
4462. Opening Metal Boxes, A. Marcilhacy, London.
4463. Producing Pictures for Advertising, W. E. Moser, London.
4464. Obtaining Motive Power, G. F. Redfern.—(*D. Huré, France.*)
4465. Obtaining Motive Power, G. F. Redfern.—(*H. M. Tartas, France.*)
4466. Umbrellas, G. F. Redfern.—(*Wirth and Co., Germany.*)
4467. Stoppering Bottles, A. Kempson, London.
4468. Root Pulpers, F. K. Woodroffe, London.
4469. Gas, B. Loomis, London.
4470. Topedoes, H. H. Lake.—(*G. E. Haight and W. H. Wood, U.S.*)
4471. Cabinet Paper Files, P. J. Schlicht, London.
4472. Button Setting Machines, H. H. Lake.—(*E. Pringle, U.S.*)
4473. Plates and Dishes, H. H. Lake.—(*A. C. Southwell, Corsica.*)
4474. Preparation of Animal Fibres, H. H. Lake.—(*J. T. Waring, U.S.*)
4475. Boots and Shoes, H. H. Lake.—(*E. Liebmann, Germany.*)
4476. Tip for Billiard Cues, &c., C. A. Latarche, London.
4477. Knitting Machines, J. H. Cooper and W. J. Ford, London.

31st March, 1886.

4478. Winding Cotton, &c., J. Schofield and J. Hitchon, Rochdale
4479. Safety Window Guard, G. B. Inglis, Bridge of Weir.
4480. Case for Greenhouse Blind, T. Elcome and J. Pemble, Margate.
4481. Tobacco Pipes, W. K. Rix, Bradford.
4482. Window-sash Fastener, C. H. M. Wharton, Manchester.
4483. Fire-bars for Boilers, T. Bell, Newcastle-on-Tyne.
4484. Umbrella Frames and Fittings, E. Sherring, Manchester.
4485. Passing Air or Gases through Liquids, J. V. Wilson, Manchester.
4486. Shoe Rivetter's Stand and Upright, I. Dilley, Northampton.
4487. Box Keys for Variable Sizes of Nuts, T. Atkinson, Halifax.
4488. Cutting the Pile of Piled Fabrics, J. Farran, Manchester.
4489. Match-box Knife, W. Singleton and E. Priestman, Sheffield.
4490. Paddle-wheels, J. Hutton, Glasgow.
4491. Incandescent Electric Lamps, F. Schaefer, London.
4492. Electric Lamp, G. H. Salvage, London.
4493. Dental Mouth Gag, E. G. B. Barlow and A. Welti, London.
4494. India-rubber Waterproof Socks, J. Rushworth, Birmingham.
4495. Pockets for Coats, Vests, &c., F. Birkett, Birmingham.
4496. Flushing Cisterns, T. and J. Holt, Liverpool.
4497. Blowing Apparatus, T. W. Beverley, Sheffield.
4498. Sealing Gas Retorts, K. Proctor and F. C. Bell, London.
4499. Gas and Sewer Valve, G. Francis, Leeds.
4500. Marine and other Boilers, T. R. Oswald, London.
4501. Brushing Cloth, J. Stead, London.
4502. Recording the Score of Lawn-tennis, G. S. Smallwood, London.
4503. Controlling the Passage of Solid Divided Matter, F. Finlayson, London.
4504. Covered Earthenware, &c., C. T. Maling, London.
4505. Watches, C. E. Jacot and E. Bovy, London.
4506. Hosiery, W. G. Johnson, London.
4507. Connecting together Lead, &c., Pipes, N. Thompson, London.
4508. Circular Knives, W. Parnall, Bristol.
4509. Fire Polishing of Glassware, J. G. Sowerby, London.
4510. Collapsible Bird Cages, R. M. Lindner, London.
4511. Steam Generators, W. Schmidt, London.
4512. Disinfection of Sewage, &c., F. Petri, London.
4513. Clipping Animals, H. Sheddon, London.
4514. Rocket Apparatus, C. Wells, London.
4515. Detached Front and Yokeless Shirt, A. F. Morgan, London.
4516. Refined Sugar, P. J. Jensen.—(*M. C. P. Barbe, Holland.*)
4517. Floating Breakwaters, F. W. Jones, London.
4518. Drying Apparatus, M. Reuland, London.
4519. Boots and Shoes, A. J. Boult.—(*G. Valiant, Canada.*)
4520. Pneumatic Water Elevators, J. G. Pohlé, London.
4521. Earth Closets, A. J. Boult.—(*W. Heap, Canada.*)
4522. Utilising Spent Liquid from Voltaic Batteries, W. S. Squire, London.
4523. Induction Apparatus, H. Müller, London.
4524. Electrical Thermophant, A. Eddowes, London.
4525. Cigar Lights, &c., G. A. Sweetser, London.
4526. Artificial Manures, H. Stevenson and E. J. Theodore, London.
4527. Pads for Horses' Feet, P. C. Beucler, London.
4528. Writing Slates, S. Pitt.—(*J. Field, New Zealand.*)
4529. Skimmer for Removing Yeast from Wort, E. L. Pontifex, London.
4530. Condenser for Tramway Engines, &c., F. J. Burrell, London.
4531. Cutting Picture Mounts, W. Martin, London.
4532. Non-intoxicating Drink, E. Hawker, London.
4533. Electric Flash-signalling Apparatus, E. S. Bruce, London.
4534. Opening and Closing the Doors of Cabs, &c., G. Wall and W. A. W. Orr, London.

1st April, 1886.

4535. Steering Gear, W. B. Thompson, Glasgow.
4536. Open-hearth Steel, W. Penrose and W. Hackney, Swansea.
4537. Belcher and other like Bracelets, J. Baker, Birmingham.
4538. Collapsible Life-raft, B. H. Thwaite, Liverpool.
4539. Valves, &c., for Baths, A. Burn and J. Macdonald, Glasgow.
4540. Tuyeres, A. J. Naden, Manchester.
4541. Steam, &c., Vessels, W. Dobson, Newcastle-on-Tyne.
4542. Steam, &c., Vessels Fitted with Side Hoppers, W. Dobson, Newcastle-on Tyne.
4543. Magic Lantern, J. W. Reffitt, Leeds.
4544. Clarifying Sewage, &c., T. Reid, Normanton.
4545. Protective Coverings for Wire Rope or Cable, C. Klauke, London.
4546. Hydraulic Packing Machinery, E. L. Bellhouse, Manchester.
4547. Brick, W. Johnson, Leeds.
4548. Engines, W. Dover, Liverpool.
4549. Steering Engines for Ships and Vessels, W. Dover, Liverpool.
4550. Sifting Flour, &c., R. and E. Fidler, Manchester.
4551. Burglar Proof Springless Sash Fastener, A. E. Nichols, Nottingham.
4552. Squaring and Tipping Billiard Cues, J. Tufnail, Reading.
4553. Deposition of Platinum by Electricity, W. A. Thoms, London.
4554. Plough, R. Purser, Carlow.
4555. Transforming Continuous Electrical Currents, A. L. N. Foster and F. V. Andersen, London.
4556. Visual Counters, W. Belle, Paris.
4557. Artificial Fishing Baits, W. Woodfield, Birmingham.
4558. Conical Screw Stopper, G. H. Jones, London.
4559. Barbed Wire, A. Caffard, France.
4560. Cases for Protecting Bottles, &c., T. B. Bates, London.
4561. Boxes, T. B. Bates, London.
4562. Railway and Tramway Passenger Carriages, G. C. Rice, London.
4563. Motor Carriages, H. A. King, United States.
4564. Cash and Parcel Transmitting Apparatus, N. W. Stearns and C. Grant, jun, London.
4565. Slide Valves, N. H. Humphrys, Westminster.
4566. Lady Cyclists' Ankle Guard, M. L. Corrie, London.
4567. Retaining a Door in an Open or Closed Position, G. H. Rayner and H. Hughes London.
4568. Spars or Booms for Torpedo Netting, J. Garvie, London.
4569. Picture-frames, E Oeser, Berlin.
4570. Saddles, F. Lavender, G. Lavender, and G. L. Lavender, London.
4571. Files for Letters, H von S. Aspang, London.
4572. Gridiron, C. S. Bailey, London.
4573. Facilitating the Starting of Tram-cars, &c., H. T. Underwood, London.
4574. Automatic Registering of Water-tight Doors in Ships, G. A. Goodwin and W. F. How, London.
4575. Secondary Batteries, W. J. S. Barber-Starkey, London.
4576. Boots, D. Southam, London.
4577. Air Extractors, A. R. Harding, London.
4578. Preparation of Animal Substances, T. D. Lawson and L. C. Marshall, Glasgow.
4579. Converting Ordinary Trembling Electric Bells into Continuous Ringing Electric Bells, H. J. Eck, C. B. Callow, and H. Wright, London.
4580. Dry Earth Closets, J. Parker, London.
4581. Centrifugal Governors, H. Kühne.—(*W. R. Proell, Germany.*)
4582. Lamps and Lanterns, W. A. Barlow.—(*J. F. W. A. Jahnke, Germany.*)
4583. Shackles, J. McAlpine, London.
4584. Operating Switches and Taps, C. Browett, London.
4585. Tackle Boxes, W. C. Latham, London.
4586. Pipe Cleaners, W. C. Latham, London.
4587. Self-oiling Axle-boxes, P. A. Newton.—(*J. W. Marshall and C. S. Bates, United States.*)
4588. Counterbalances for Window Sashes, &c., W. F. Lennon, London.
4589. Bicycles, B. S. Whitehead, London.
4590. Cleaning Boiler, &c., Tubes, H. H. Lake.—(*F. M. Clark and F. R. Low, United States.*)
4591. Distance Measuring Apparatus, H. H. Lake.—(*K. Schneider, United States.*)
4592. Measuring Land, D. Ramsay, jun., Liverpool.
4593. Brakes for Lifts, &c., A. J. Boult.—(*G. Wartlinger and S. G. Rosenberg, Germany.*)
4594. Letter Files, &c., A. J. Boult.—(*J. R. Pitt, United States.*)
4595. Automatic Sighting and Aiming Apparatus, C. J. P. Gravier, London.
4596. Preventing Fungus in Flooring, C. D. Abel.—(*J. H. Timm, Germany.*)
4597. Lock Nuts, J. Scattergood, London.

2nd April, 1886.

4598. Automatic Fire Extinguisher, R. Leigh, Bolton.
4599. Preserving Eggs, R. Ashton, Heaton Mersey.
4600. Permanent Ways, P. Kirk, Manchester.
4601. Gas-fired Furnaces, B. D. Healey, Liverpool.
4602. Miners' Safety Lamps, J. S. Donald, Newcastle-on-Tyne
4603. Bench Plugs for Holding Down Work, J. Rawlings, London.
4604. Lids for Saucepans, A. Harrison and J. Wright, London.
4605. Securing Railway Doors, J. S. Rigby, Liverpool.
4606. Wrought Iron Flanges, &c., J. Edwards, Wednesbury.
4607. Railway Signalling Apparatus, G. B. Sharples, Manchester.
4608. Studs and Bobbins for Twisting Yarns, &c., H. Ainley, Halifax.
4609. Destruction of Town Refuse, T. G. Hardie, Burnley.
4610. Buildings, J. C. Bloomfield, Dublin.
4611. Protecting Exposed Luminous Advertisements, J. Hicken, Landport.
4612. Adjustable Brackets for Carrying Shaft Bearings, F. G. and A. C. Hands, and W. Thomas, Birmingham.
4613. Punching and Eyeletting Machines, E. A. Pallister, Leeds.
4614. Marine Boilers, C. C. Marley, Middlesbrough.
4615. Making Exposures in Cameras, C. Cusworth, London.
4616. Construction of Fire Boxes, &c., D. Caird, Liverpool.
4617. Stretching Wire Fencing, T. Dussieux and T. Zeitz, Sheffield.
4618. Universal Dovetail Carriers, J. Anderson, Newcastle-on-Tyne.
4619. Collecting Moneys, J. W. Blakey, Leeds.
4620. Handles for Knives, J. Nixon and F. Richards, Sheffield.
4621. Harness Ornaments, S. Crosbee, Birmingham.
4622. Single Chain Skip, C. E. Vernon, London.
4623. Water Filters, P. Hikely and J. Radcliffe, Manchester.
4624. Actinometers for Photography, W. F. Stanley and W. L. Sarjeant, South Norwood.
4625. Compound for Washing Painted Articles, T. B. Harrison, London.
4626. Vices, J. Kenyon, J. Barnes, and R. W. Kenyon, Liverpool.
4627. Manufacture of Wrought or Fashioned Hosiery, R. Hunt, London.
4628. Magazine Repeating Rifles, G. E. Vaughan.—(*J. Werndl, Austrian Small Arms Manufacturing Company.*)
4629. Apparatus for Holding a Roll of Paper, W. W. Colley, London.
4630. Stranded Electric Conductors, E. W. Lancaster, London.
4631. Cleaning Tin Plates, D. Williams, Swansea, and E. Jones, Kent.
4632. Stopping Bottles, H. Kent, London.
4633. Corrugated Boat Nails, E. J. Preston and T. Allart, London.
4634. Transmitters, G. A. Nussbaum, London.
4635. Boat Building, S. E. Saunders, London.
4636. Boats and Canoes, S. E. Saunders, London.
4637. Stays and Corsets, W. H. Symington, London.
4638. Oil Cans, W. Fletcher, London.
4639. Ladies' Boas, R. F. Seals, London.
4640. Sewing Machines, A. Anderson and R. A. F. Pollock, Glasgow.
4641. Packing for Stuffing-boxes of Engines, S. Lamont and P. MacLellan, Glasgow.
4642. Hammer Press, A. Bedford and C. F. Millar, London
4643. Steering Attachments for Velocipedes, A. Westerfrölke, London.
4644. Hansom Cabs, C. A. Reade, London.
4645. Elevators Actuated by Compressed Air, F. Backeljau, London.
4646. Metallic Buildings, Z. Danly, London.
4647. Removing Tar from Hydraulic Mains, J. Dillamore, London.
4648. Lubricators for Steam Engine Cylinders, T. Bowen, London.
4649. Brake for Vehicles, W. Rendall, London.
4650. Fire-bars and Grates for Engines, J. Thomas, jun., London.

4651. Boats and Apparatus for Fishing, W. Coppin, London.
4652. Powder Cases, A. Noble, London.
4653. Directing the Discharge of Ordnance Torpedoes, &c., at Night, H. H. Grenfell, London.
4654. Accumulators, C. H. Murray, London.
4655. Ascertaining the Length of Material in Rolls of Cloth, &c., J. Barrett, London.
4656. Filters, J. S. Sawrey, London.
4657. Type-writing and Matrix Machines, G. W. Baldrige, London.
4658. Fire-extinguishing Apparatus, H. H. Lake.—(*R. A. Ballon, United States.*)
4659. Picture Rod, &c., Hooks, C. J. Harcourt, London.
4660. Altering the Potential of Electrical Currents, J. D. F. Andrews, London.
4661. Advertising Apparatus, P. H. Baily, London.
4662. Automatic Electrical Distribution, &c., F. King, London.
4663. Electric Generators, F. F. Stögermayr and V. Glassner, London.
4664. Asbestos, &c., Packing, G. G. M. Hardingham.—(*R. N. Pratt, United States.*)
4665. Permanent Way of Light Railways, A. H. Rowan, London.

3rd April, 1886.

4666. Folding Chairs, J. T. Moore, Crewe.
4667. Giving off Exhalation from Tar, G. M. Nicolaus, London.
4668. Propelling and Towing Boats, &c., J. Parkes, Manchester.
4669. Folding and Measuring Fabrics, W. H. Hacking, Manchester.
4670. Covering Preserve Jars, &c., E. Pickard, Mansfield.
4671. Cooking Ranges or Kitcheners, D. Cowan, Glasgow.
4672. Shirt Fronts, A. Harrison, Manchester.
4673. Fire-grate Fuel Economisers, J. Maddock, Oaken Gates, Shropshire.
4674. Clearing Snow from Railways, &c., J. H. Bell and W. Rockliffe, Monkwearmouth.
4675. Metal Frame for Bag Purses, &c., I. Brager —(*Messrs. Feldmeier and Bock, Germany.*)
4676. Metal Frame for Bag Purses, &c., I. Brager.—(*Messrs. Feldmeier and Bock, Germany.*)
4677. Purse Fastening, I. Brager.—(*Messrs. Feldmeier and Bock, Germany.*)
4678. Washing Machines, T. Bradford, Manchester.
4679. Caramel, C. W. N. Wallace and C. J. H. Rarry, London.
4680. Directing the Course of Projectiles Automatically, C. E. Marr, London.
4681. Valves for Air-compressing, &c., Pumps, J. G. Kinghorn, Liverpool.
4682. Surgical Elastic Hosiery, J. H. Haywood, London.
4683. Balls for Golf, &c., Games, W. Park, jun., Glasgow.
4684. Valves and Fittings for Fluids, I. Ross, Glasgow.
4685. Appliances and Fittings for Pumps, &c., W. Stephenson, Glasgow.
4686. Coverings for Horticultural Purposes, T. C. March, London.
4687. Colouring Matter, T. Maxwell and J. Young, Glasgow.
4688. Two-speed Driving-gear for Velocipedes, W. C. Burton, Rochdale.
4689. Hygeia Anti-germ Hat, J. T. Robinson, Reddish.
4690. Cue Rests, J. S. Burroughes, London.
4691. Holder for Thread, &c., Materials, J. Frank, London.
4692. Screens for Middlings Purifiers, G. Daverio, London.
4693. Refrigerating Apparatus for Roller Mills, G. Daverio, London.
4694. Water-heating Apparatus, C. Toope, London.
4695. Separation of Gold, &c., from Ores, &c., J. Noad, London.
4696. Sportsman's Wrist Strap, D. Cavé, London.
4697. Breech-loading Fire-arms, J. G. Howard, London.
4698. Pipes for Smoking, A. Strauss, London.
4699. Gill-boxes, J. C. Walker, London.
4700. Furnaces, E. N. Henwood, London.
4701. Railway Signals, E. French, Walsworth.
4702. Working of Looms, H. H. Lake.—(*C. Theis, Germany.*)
4703. Marking Scores at Billiards, &c., C. R. Heap, London.
4704. Artificial Fire Blocks, G. F. Redfern.—(*A. Dubuisson, Belgium.*)
4705. Heating Apparatus, G. F. Redfern.—(*J. Leyrat, France.*)
4706. Moulding for Pressing Meat, &c., W. Benbow, London.
4707. Obtaining Fresh Water on Board Ships, J. Kirkaldy, London.

5th April, 1886.

4708. Sash Fasteners, F. Gaunt, Birmingham.
4709. Stencilling Designs on Front Sights of Fire-arms, H. P. Miller, London.
4710. Preventing Scale being deposited on Tops of Furnaces of Marine Boilers, &c., J. Rankine, North Shields.
4711. Reflecting Gas Light and Heat Radiator, W. Hibbert, Barnsley.
4712. Hosiery Machinery, W. H. Dorman, Stafford.
4713. Flanged Bobbins, J. H. Wilson and J. Greenwood, Manchester.
4714. Tram Rails, P. W. Walker, Birmingham.
4715. Vessels for Holding Mineral Oils, &c., G. A. J. Schott, Bradford.
4716. Power Loom Weaving, W. Strang, jun., Glasgow.
4717. Checking Passengers, P. Ogden, Manchester.
4718. Grinding Stoppers for Bottles, J. G. Liversidge, Leeds.
4719. Machine for Softening Straw, C. F. Richter, Manchester.
4720. Marking on Canvas Targets, H. E. C. Kitchener, Farnborough.
4721. Testing of Mains for Leakage, J. H. Lyon, Cosham.
4722. Impressing Railway Tickets, W. Smith, London.
4723. Treatment of Waste Tin Cuttings, T. Fenwick, London.
4724. Caster Bowl, T. Silverwood, Halifax.
4725. Music Desk and Portfolio, A. A. Chapman, London.
4726. Measuring the Height of Human Beings, W. F. Stanley, South Norwood.
4727. Slide Carriers for Magic Lanterns, W. J. Coles, London.
4728. Combs, W. A. Barlow.—(*F. Engel, Germany.*)
4729. Dust Collectors, A. C. Nagel, R. H. Kaemp, and A. Linnenbrügge, London.
4730. Stopping Bottles, W. Hardy, jun., London.
4731. Apparatus for Formes and Types, F. X. Hölzle, London.
4732. Cushioning for Vehicle, &c., Seats, J. Robertson, London.
4733. Fastening for Casement Sashes, &c , G. J. Body, London.
4734. Boots and Shoes, G. Knight, London.
4735. Cutters of Reaping, &c., Machines, J. B. Rock, London.
4736. Non-conducting Covering for Pipes, &c., H. E. Newton.—(*M. Hanmore, R. Van S. Mattison, and H. G. Keasbey, U.S.*)
4737. Caustic Powders, G. J. C. Marie, Baron de Liebhaber, London.
4738. Dyeing Felt, &c., Hat Bodies, B. Herzberg, London.
4739. Measuring Line, F. Weldon, London.
4740. Preservation and use of Tea Dust, S. F. Smith, London.
4741. Reducing Old Steel Rails to Plates, &c., A. J. Boult.—(*E. B. Stocking, U.S.*)
4742. Treating Barium and Strontium, H. L. Pattinson, jun., London.
4743. Obtaining Benzine, &c., J. C. Mewburn.—(*La Société Renard et Durou, France.*)
4744. Black and other Dyes, J. C. Mewburn.—(*La Société A. Collineau et Cie., France.*)
4745. Coating Pills, W. W. Talbot, London.
4746. Inhalers for Curative Purposes, J. L. Crawford and R. Lees, Glasgow.
4747. Bread, J. C. Pooley, London.
4748. Connecting Drains to Main Drains, T. C. T. Walrond, London.
4749. Oxyhydrogen or Lime-light Apparatus, G. A. Williams, London.
4750. Treating Lead and other Ore, J. W. Hall.—(*G. T. Lewis, U.S.*)
4751. Application of Magnetism for the Separation of Metals, H. S. Maxim, London.

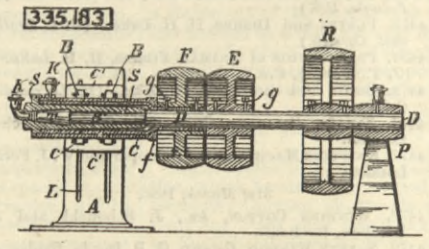
SELECTED AMERICAN PATENTS.

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

335,183. Loose Pulley, *Gardener T. Eames, Cincinatti, Ohio.—Filed December 29th*, 1885.

Claim.—(1) The combination with the hollow journal G and recessed box C, of the adjustable hanger A, as

335,183.

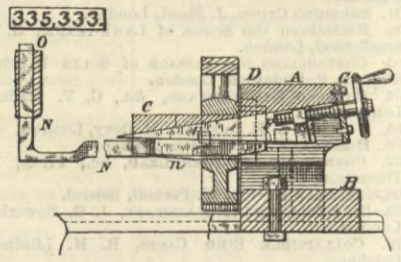


set forth. (2) The combination, with the box C and bearing S, of the hollow journal G, and shaft D, as set forth.

335,333. Key Seat Cutter, *Arza M. Benson, Cleveland, Ohio.—Filed November 6th*, 1885.

Claim.—(1) In a key seat cutter, a cutting tool, N, provided with portion n^3, of less vertical dimension than the main longitudinal body portion of the tool, substantially as set forth. (2) In a key seat cutter, a cutting tool N, provided with flattened portion n^3, of less vertical and greater horizontal dimensions than the main longitudinal body portion of the tool, substantially as set forth. (3) In a key seat cutter, a cutting tool N, provided with flattened portion n^3, in its longitudinal body, and with angular shank O, substantially as set forth. (4) In a key seat cutter, a cutting tool N, having a head n, of greater vertical dimension than the main longitudinal body portion of the tool, substantially as set forth. (5) In a key seat cutter, the combination of the slotted mandril wedge and cutting tool, said wedge having bearing on the cutting tool only on the latter's head in a vertical plane substantially with the cutting edge, the remaining longitudinal body of the cutting tool being clear of the wedge, substantially as set forth. (6) In a key seat cutter, the combination, with a mandril holder, A, having its face provided with chambered socket D, of a mandril C, having its rear extremity provided with excentric flange c, fitting in said socket, substantially as set forth. (7) In a key seat cutter, the combination, with the mandril holder A, having its front end face provided with chambered socket D, of mandril C, having its rear extremity provided with the vertically and laterally excentric flange c, and fastening devices a, which secure said flange to the

335,333.

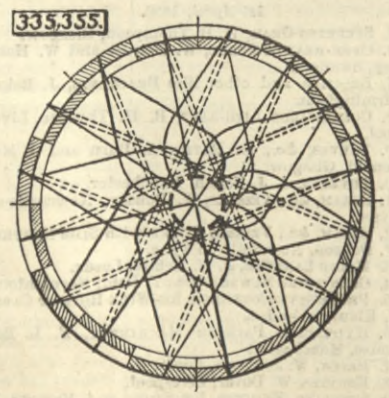


socket substantially as set forth. (8) In a key seat cutter the combination with a mandril formed with a longitudinal and inclined slot, and a wedge adjustably movable in said slot, of a cutting tool working in said slot and having its cutting head of both horizontal and vertical increased dimensions over the other immediately adjacent portions of said tool, substantially as set forth. (9) In a key seat cutter, the combination, with a mandril formed with a longitudinal slot, of a cutting tool working in said slot and having its head of greater horizontal dimension than the remaining portion of the tool that works in the slot, whereby said head only has bearing against the walls of the slot, substantially as set forth. (10) In a key seat cutter the combination with a mandril holder having a chambered socket on its inner face, of a mandril provided with a flange detachably fitting in said socket, substantially as set forth. (11) In a key seat cutter, the combination with mandril holder A, provided with rear recess I, of wedge E, fitted in said recess, and provided with lug e, and pinching screw F, working in and through said lug, substantially as set forth. (12) In a key seat cutter, the combination with mandril holder A, provided with rear recess I, of wedge E, fitting in said recess and provided with lug e^1, and pinching screw F, working through said lug, and perforated face plate G, through which the shank of said screw works, substantially as set forth.

335,355. Dynamo-electric Machine, *Carl Hering, Philadelphia Pa.—Filed October 31st*, 1885.

Claim.—(1) In a dynamo-electric machine, a cylindrical armature, each of whose coils is divided into two equal parts and placed on the armature in planes parallel to each other alternately as the inner

335,355.

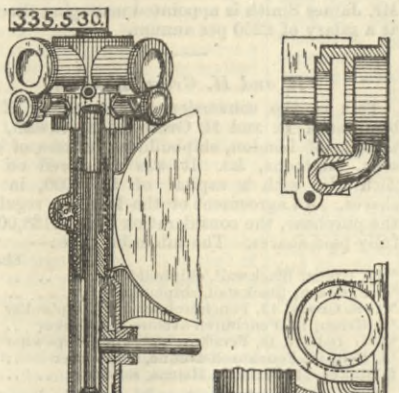


and outer layers of wire wound thereon substantially as described and specified. (2) In a dynamo-electric machine in which each of the armature coils is divided into two equal parts, placed alternately as the inner and outer layers of wire thereon, an armature in which a greater equality of the length of the wire in the separate coils thereof is obtained by winding the separate halves of the coils thereon in planes parallel to each other.

335,530. Steam Engine, *Mirabeau N. Lynn, Rising Sun.—Filed December 31st*, 1884.

Claim.—(1) In combination with the main casing, the cylinders mounted thereon, and exhausting into said casing, the main shaft having bearing therein and the reversing mechanism and driving gears located in the supplemental casing applied to the main casing and communicating therewith, as described, whereby all the working mechanism is protected and subjected to the lubricating action of the exhaust steam and oil substantially as described. (2) In combination with the main and supplemental casing connected and mounted upon the boiler, as described, the driving shaft extending through said casing and supported in bearings therein, the crank pitman and cylinders located at one end, and the driving gear at the opposite end and within the said casing, substantially as and for the purpose set forth. (3) In combination with the main shaft, the crank located at one end, and the driving gears at the other, the excentric and shifting mechanism located intermediate the crank and driv-

335,530.



ing gear, and the casing inclosing the shaft and the operating mechanism, substantially as described. (4) In a direct-acting steam engine, a frame for the actuating mechanism, consisting essentially of a main casing to which are applied the piston and valve cylinders, as described, and provided with bearings for the main shaft and the supplemental casing applied to and forming an extension of the main casing, said supplemental casing being provided with bearings for the main shaft and counter shaft, substantially as and for the purpose set forth. (5) In a direct-acting steam engine, the main frame having the main casing carrying the piston and valve cylinders, and adapted to inclose the crank on the driving shaft, and the supplemental casing applied to the end and forming a continuation of the main casing, said supplemental casing being adapted to receive the devices for shifting the excentric and both of said casings with bearings to support the shaft, and a flange or bracket e, for application to the boiler, substantially as described. (6) The combination in a direct-acting steam engine, of the main casing carrying the radial piston and valve cylinders,

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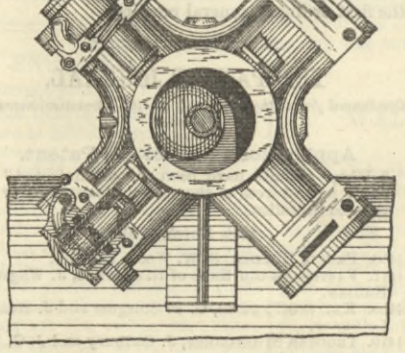
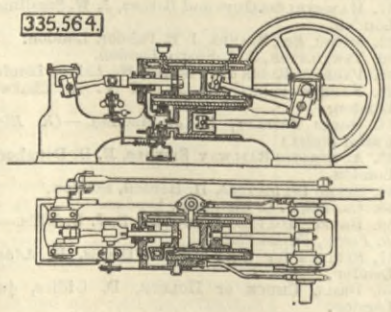


the supplemental casing applied to and forming an extension of the main casing, a driving shaft extending through both of said casings and supported in bearings therein, devices, such as described, mounted upon the driving shaft for reversing the valve excentric and located within the supplemental casing, and a crank to which the pistons are connected, located within the main casing substantially as described. (7) In a direct-acting steam engine the combination, with the main casing carrying the radial piston and valve cylinders, and the supplemental casing applied to and forming an extension of the main casing, of the crank shaft extending through both of said casings and carrying the adjustable valve excentric, said shaft having its bearings in the ends or heads of the two casings, with a third bearing intermediate the crank and valve excentric, substantially as described. (8) In a direct-acting steam engine wherein the operating parts are inclosed, the combination of the main and supplemental casings, the piston and valve cylinders applied to the main casing, the main shaft extending through both casings, the crank and valve excentric applied to the said shaft at one end and within the main casing, the driving gear applied to the opposite end, and within the supplemental casing, and the valve adjusting mechanism applied intermediate the said crank and gear, substantially as described.

335,564. Gas Engine, *John Charter, Sterling, Ill.—Filed November 5th*, 1884.

Claim.—(1) The combination of a working cylinder provided with a transfer and a power piston, and

335,564.

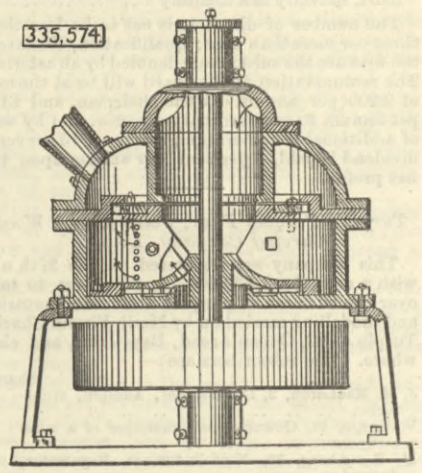


crank connections, substantially as described, whereby the charge is transferred from one side of the transfer piston and compressed between the two pistons. (2) The combination with the cylinder D, and working piston of the transfer piston A, connected with a rock shaft and toggle levers, and rod f, connecting said levers with a crank pin on the fly wheel substantially as set forth. (3) The combination, of the cylinder D, having ports 2 3, and an extension 4, of the port 3, and the pistons A B, casing D^1 and slide valve T substantially as described. (4) The combination with the cylinder and ports 2 and 3, of a valve casing D^1, slide valve T, having a flame port, v, and passage 12, and the casing D^1 having an internal channel arranged as set forth. (5) The combination of the casing D^1 having a channel 10, valve T having a flame port v, and passage 12, and a casing D^1 having a port 3, and channel 15, substantially as described. (6) The combination with the slide valve T and passage 12 and port v of a plug T^2, having a terminal chamber and passage v^3 substantially as described.

335,574. Pulverising Machine, *Willard M. Fuller, New York, and John J. Hayes, Brooklyn, N.Y.—Filed July 9th*, 1885.

Claim.—(1) The combination with the grinding cylinder of the revolving distributing centre having hollow wings forming air pockets, and provided each with an inlet from the exterior of the machine and an outlet to the interior of the machine for delivering air to and from such pockets, substantially as and for the purpose set forth. (2) The combination with the grinding cylinder having a central opening in its bottom, of the revolving distributing centre having hollow wings forming air pockets, such pockets having bottom openings communicating with the external air through said central opening, and with air outlets to the interior of the machine substantially as set forth. (3) The combination with the grinding cylinder, of the revolving centre having hollow wings communicating with the external air and provided with openings on the rear sides of the wings for delivering air to the machine substantially as set forth. (4) The combina-

335,574.



tion with the grinding cylinder having a central opening in its bottom, of the revolving centre having hollow wings provided with openings on their rear sides delivering air to the machine and bottom openings communicating with the external air through the central opening in the bottom of the grinding cylinder substantially as set forth. (5) The combination with the grinding cylinder of the revolving distributing centre turning therein, composed of bottom disc, top ring and radial wings, said bottom disc travelling over the floor of the grinding cylinder so that a horizontal air passage is formed between them, and an upwardly projecting shoulder on the bottom of the grinding cylinder surrounding the bottom disc of the revolving centre for protecting its edge and the air opening thereunder, substantially as set forth. (6) The combination with the grinding cylinder, of the revolving distributing centre turning therein composed of bottom disc, top ring, and radial wings and a removable ring on the bottom of the grinding cylinder surrounding the edge of the bottom disc of the revolving centre, substantially as set forth.

335,608. Means for Cleaning out Conduits, *John P. Messer, Cedar Rapids, Iowa.—Filed May 12th* 1884.

Claim.—The described device for cleaning conduits, consisting in a ball somewhat smaller than the inside of the pipe and practically spherical in form, whereby it is adapted to follow all the sinuosities of the pipe

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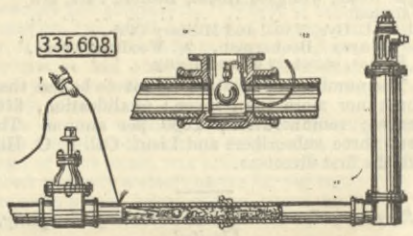

in combination with a cord, whereby the movements of the ball may be regulated from the outside of the pipe, substantially as set forth.

335,695. Water Tube for Boilers, *James Hartley, Brooklyn, N.Y.—Filed April 27th*, 1885.

Claim.—(1) The herein described wrought metal water tube for boilers or heaters, the same being provided with an offset or extended part between the circular or cylindrical ends, and being twisted so as to vary the location or direction of the offset between its extremities, substantially as shown and for the purposes set forth. (2) The combination of two or more water tubes of the character herein set forth, each made of wrought metal and secured in place by expanding the ends, said tubes being constructed substantially as shown, with cylindrical ends of unequal lengths, and arranged so that the offset upon

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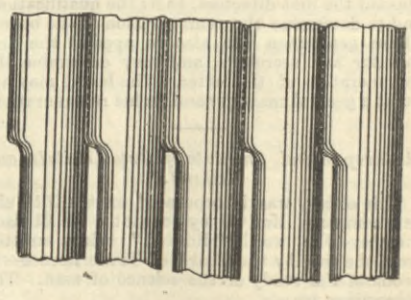

one shall bear against the material of the one next adjacent for a portion of its length, leaving open spaces between the tubes for the remaining portion for the purposes and objects named. (3) In a wrought metal water tube of the character herein set forth, having an offset between the ends, the cylindrical ends made of unequal lengths, and arranged to be inserted and secured in the end boxes by expanding the ends of the tube therein, and without disturbing any of the other tubes, substantially as and for the purposes herein set forth.