AMERICAN BRIDGE DESIGN.

By ROBERT HUDSON GRAHAM.

No. II.

THE subject of transverse sway-bracing is of such vast importance, and its study has been so deplorably neglected, that I venture to complete my sketch of what Professor Waddell has to say about it. After taking account of the stresses set up in the bracing by a side wind, Professor Waddell proceeds to deal with those arising from inequality of dead-load distribution when only one line of rails is covered by a rolling load. We are glad to be able almost wholly to endorse his treatment of this case; although, as we shall presently show, his results are attainable by a much more direct and obvious method. Taking Fig. 4, Professor Waddell reasons as follows:—"When only one track of a double track bridge is covered by the moving load, according to the law of the lever, one truss receives more load than the other. Now, if the two trusses could act independently, this distribution would hold while the load covered the track; but if the two trusses were connected by perfectly inelastic vertical sway bracing they would have to deflect equally, which could only occur when the loads on each truss were equal, so that a portion of the load equal to the difference between the greater division by the law of the lever and one-half of the whole load would have to be transferred by the vertical sway bracing. In reality, neither of these conditions will exist, the true condition lying between the two; for the trusses do not act independently as if there were no vertical sway bracing, and the latter is far from being inelastic. What the actual transferred load is it is impossible to say, but it will be making an error on the side of safety if it be assumed that the load is equally divided between the trusses; any extra iron that may be thereby used in the vertical sway bracing will be well employed in resisting vibration. Under this assumption let us investigate the stresses in the bracing. Let the notation be as in Fig. 4, R and R¹ being the reaction due to the weight W, distributed according to the law of the lever, so that

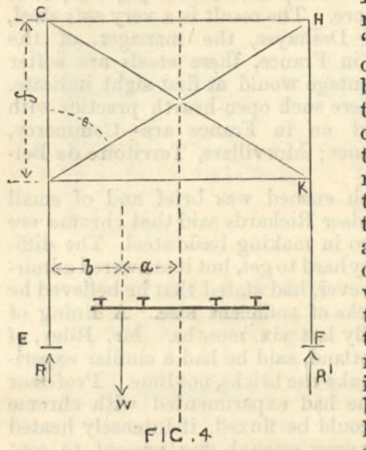


FIG. 4

$$R = W\,\frac{2a + b}{2(a + b)}.$$

Let G be the weight transferred by the bracing, then

$$G = R - \tfrac{1}{2}W = \frac{W a}{2(a + b)}.$$

The stress in the vibration rod is, therefore,

$$T = G \sec.\,\theta = \frac{W a}{2(a + b)}\,.\,\sec.\,\theta.$$

The stress in J K is found by passing a plane to cut G H, J K, and J H, supposing that the only weight acting is $\frac{W a}{2(a + b)}$ at E, and taking the centre of moments at H. This gives

$$(J\,K) = \frac{W a}{2(a + b)}\,.\,\frac{2(a + b)}{f} = \frac{W a}{f}.$$

Again, taking the centre of moments at J, and using the same cutting plane, we find the stress in G H to be zero; for the moment of increase of weight at F is balanced by the moment of increase of reaction at that point,* making the resultant moment of the external forces zero. To find the bending effect upon the post at K let us pass a plane cutting K F and J E, and take the centre of moments at K, then

$$M = \frac{W a}{2(a + b)}\,.\,2(a + b) = W a.$$

If h be the distance between centres of gravity of post channels and an intensity of 4 tons be employed, the area of one channel necessary to resist this bending moment will be

$$A = \frac{M}{4h} = \frac{W a}{4h}.$$

But as this effect does not exist at the same time as the maximum load stress upon the post H F, it need be considered only when the post is very light. To ascertain whether it needs consideration, find the stress on the post with one train only on the bridge, reaching from the most remote end of the span to the post considered, and under the supposition of an equal distribution of the train load between the trusses; then proportion the post to resist this stress according to the usual method, and to one-half of the section thus found add the value of A in the last equation. If the sum exceed the area of one of the post channels required to resist the maximum live and dead load stresses when both tracks are partially covered by the assumed moving loads, then the post section is to be increased accordingly. The vibration rods should be proportioned to resist the transferred load stress, using an intensity of 5 tons, or to resist the sum of the transferred load stress and the wind stress under 30 lb. pressure, using an intensity of 7½ tons. In double track bridges without sway bracing the trusses will probably act nearly independently, but of this one cannot be certain, so it may be well to calculate the formula for the bending effect on the upper lateral struts due to the transferred load under the assumption of equal distribution between the trusses, and apply it to a practical case. Let the notation be as in Fig. 4, but let s have the same signification as in Fig. 3 *ante*, then the bending moment upon the strut will be—

$$M = G\,[2(a + b) - s] \quad . \quad . \quad . \quad . \quad (4)\text{"}$$

The above treatment of transferred load is unassailable except in two points, and in so far that the results can be derived by a much quicker method, without previously finding the reaction R or making any sectional planes. Thus, let M = the moment of torsion due to excentric loading, then

$$M = W a = G\,.\,2(a + b),$$

whence

$$G = \frac{W a}{2(a + b)},\ T = G \sec.\,\theta,\ (J\,K) = G \tan.\,\theta,$$

all of which results agree with those previously obtained. But now I should like to ask what difference in fact or principle lies between a torsional moment due to wind and one due to dead weight? In both cases, Figs. 2 and 4, the frame is in torsion under a left-handed couple. Returning, for example, to case Fig. 2, discussed in the first paper, it will be seen that the centre of application of the total wind force, R = 2 (P + P¹), is applied excentrically at a height, say y, above the half-depth, or more correctly speaking, above the centre of gravity of the section, hence the frame is under a torsional moment due to wind expressed by M = 2 (P + P¹) y. There would then pass through the neighbouring strut J K a transferred load derived from the equation*

$$G^1\,.\,f = M, \text{ or } G^1 = 2(P + P^1)\,.\,\frac{y}{f}.$$

The tension in the diagonal G Kwould be G¹ sec. θ^1 where θ^1 = 90 deg. − θ. The equal and opposite stresses in the columns would be each equal to V = G¹ tan. θ^1, forming a couple V . b equal and opposite to the torsional wind couple R y, as can be immediately proved by making the given substitutions, and noting that tan. $\theta^1 = f \div b$. Whether this treatment be right or wrong, it has the merit of being consistent and not self-contradictory. It depends upon the assumption that the wind-loading is excentric, for under even loading, that is, when the centre of wind forces coincides with the centre of gravity of the section, the scheme of stresses would be different, being determined on the assumption that the frame moves sideways as a whole. In any transverse system the safest plan is to follow the effect of a given force step by step. Let us, for instance, take the case of unequal side loading, Fig. 4. Thus, if I impress a force G upon the toe E of the frame it will deflect, and G will distribute itself into a pull G sec. θ along J H, and a dig or thrust G tan θ along J K. Following the tension G sec. θ, we see that it will resolve itself into a pull G tan. θ along G H, which as the bar meets it is a thrust, and a downward force G along H K, under the influence of which the toe F deflects to the level of the depressed toe E. The frame rests in this depressed position till the train has passed over, after which reaction takes place; that is the toe E, being suddenly relieved of the weight G, rises and impresses a tension G sec. θ upon the other vibration rod G K, and a thrust along G H. The tension G K then resolves itself into a dig along J K and an upward force along F K, under the action of which the toe F rises to the level of E, and the frame is once more in state of equilibrium. An analysis of this kind gives us a very clear notion of the reason why the rods G K and and J H go by the name of vibration rods. It agrees with that of Professor Waddell except in one particular. It will be seen on reference that the professor holds that the horizontal component of G tan θ at H is free to produce a bending moment G tan. θ × H K at K; whereas I hold that the horizontal component at H is not free, but met and resisted by the bar G H, in which it induces a thrust G tan θ. This thrust is equal and opposite to the thrust in J K, and between them they represent a couple:

$$G \tan.\,\theta\,.\,f = \frac{W a}{2(a + b)}\,.\,\frac{2(a + b)}{f}\,.\,f = W a$$

or the moment of torsion in the frame.

A glance at the expression in Equation 4 immediately convinces us how it was that Professor Waddell came to imagine that a bending moment could arise at the section A in the strut G H Fig. 3, when under wind load. He drew the conclusion from a false analogy. It is quite true that if the frame, Fig. 3, were acted upon by a downward force G in the line H F, this force could not be transferred to the opposite column without creating a moment at A, if not exactly equal to that given by Professor Waddell, at least equal to G × $\overline{A\,C}$. The torsion couple would then be in the struts. But under excentric wind-loading the load is not transferred from column to column, but from strut to strut, and the torsion couple is then in the columns. The difference between the two cases is simply that the struts and columns have interchanged places in virtue of the load veering through 90 deg. Although I have in this article dwelt at some length upon the nature of the stresses in a more complex system of tranverse bracing, I view the results with diffidence, and should like to see the question of stresses in transverse bracing thoroughly threshed out, taking into account the many conditions which tend to alter their natures and amount. It had been my intention to deal with Professor Waddell's ideas upon rivetting, and to criticise his peculiar system of calculating rivet-sections to resist bending instead of shear; but the subject of cross-bracing has carried me so far that I must conclude with the remark that engineers will find a vast collection of useful tables and plates in these memoirs, such a list of all the forms of T I and ⊏ sections rolled by the best English, American, and Belgian firms, some of which were collected for the author by the indefatigable secretary of the Institution of Civil Engineers, Mr. James Forrest, and others were collected by the author himself. There is also a series of plates giving the details of a whipple truss, the stresses and corresponding scantlings in whipple trusses of different spans, and other ready-made data of more or less value. But the reader must pick his way, and take nothing for granted the accuracy of which he has reason to suspect.

* This is wrong, for what is true of F ought to be equally true of E; as a matter of fact, there is a stress G tan. θ in G H, the proof of which is given later in this article; there is no bending moment at K as stated above.

* Here I take $G_1 f = M$; but if the vibration rod extended to the foot of the column, we should obviously have $G\,.\,2f = M$; and even in the given case G_1 might be less than given in the text. To find the stress in any member we must find the algebraical sum of the stresses arising from the transferred load A_1, and the remaining direct load $R - 2\,G_1$ applied at the centre of gravity of the section. The total shearing load at the top and bottom of the section is $G_1 + (R - 2\,.\,G_1) \div 2 = R \div 2$.

THE IRON AND STEEL INSTITUTE.

ON Friday morning, the 14th inst., the first paper read was by Mr. Hamilton Smith, on

WROUGHT IRON CONDUIT PIPES.

This was a description of the wrought iron pipes extensively used in the United States for hydraulic pump and other purposes. They are made up to 30in. diameter.

These pipes, as a rule, are made at the mine, the requisite machinery costing less than £100. The iron is from ·065 to ·134in. (Nos. 16 to 10 Birmingham gauge) in thickness, with a double row of cold rivets for the longitudinal seam when the pressure is to be large. The only test made of the quality of the iron is the judgment of the pipe-maker, who can generally discover and reject sheets of bad quality by defects manifested when the plates pass through the rolls; in fact, this is one of the chief reasons why the mine-owners have preferred to make the pipes themselves. The length of the separate joints is from 18ft. to 25ft., one end being slightly smaller than the other end. As a protection against rust each joint is immersed for several minutes in a bath of boiling asphaltum and coal-tar; a little rosin is added when a glassy surface is desired, and sometimes a little fish oil. This immersion results in a thorough coating of the pipe, both inside and outside, and is vastly superior to any application of paint. When the pipes are coated properly the protection appears to be perfect. The several joints are then joined together, stove-pipe fashion, the lower joint being shoved firmly into place by jack-screws. When the fit is slack a piece of tarred canvas is wrapped around the small end; wedges of soft pine wood are sometimes driven in where the fit is a bad one. Such pipes are laid on the surface of the ground, and can be put together or taken apart with great ease and at small expense. When a line of such pipe is laid by skilful men with ordinary care, although the length may be several thousand feet with a pressure at the lower end as great as 450ft., there are but trifling leaks, which generally can be stopped by putting sawdust into the inlet end of the pipe. As an illustration of the tightness of such rough joints, the author cited a main laid by himself for supplying water power, having a length of two miles and a maximum pressure of 550ft. The leakage from this pipe did not average more than three or four cubic feet a minute, although the only protection from changes of temperature was a couple of boards tacked together and placed over the pipe. The extreme range of temperature was from 10 deg. to 107 deg. Fah. in the shade. San Francisco, a place of some 300,000 inhabitants, receives its water through two lines of such pipes, and a third pipe, many miles in length and of large diameter, is now being laid for an additional supply. For permanent conduits the joints of a pipe of considerable diameter are generally rivetted together; for small diameters with high pressures lead joints are used. Such conduits are, of course, placed in trenches, and covered with earth in order to avoid excessive alternations in contraction and expansion; slip-joints need not be used, as the pipes are sufficiently elastic to permit changes in length due to variation of the temperature of the water. The following statement will illustrate the Pacific Coast practice with conduit pipes, the flow in all cases being caused by gravity:—

Name.	When laid.	Length in feet.	Diameter in inches.	Maximum pressure in vertical feet of water.	Maximum tensile strain in lbs. on iron per sq. in.	Description of pipe.
Cherokee ..	1870	12,798	30	887	17,549	Plate iron, double rivetted.
Virginia City	1872	37,100	11	1720	about 15,000	Plate iron, double rivetted.
	1873	37,100	10	1720	(?)	Lap-welded tubing; outer screw couplings
Texas Creek	1878	4,439	17	760	about 18,000	Plate iron, double rivetted.
Humbug ..	1868	1,194	26	120(?)	11,500	Single rivetted iron $\frac{1}{16}$in. in thickness; two pipes, each 26in. diameter, laid side by side.

The two Virginia City pipes are laid side by side; the lead joints for the rivetted pipe, under the enormous pressure of 1700ft., at first gave considerable trouble; the law-welded pipe gave no trouble whatever. The general tensile strain on the Texas Creek pipe is about 16,500 lb. per square inch.

The discussion which followed was very short and of small importance; its drift was that these pipes could be made just as well in this country as in America if a demand existed for them.

Dr. Sorby then delivered a lecture on

THE APPLICATION OF VERY HIGH POWERS TO THE STUDY OF THE MICROSCOPICAL STRUCTURE OF STEEL.

We call this a lecture, for although Dr. Sorby had prepared a paper he did not read it, but gave its substance instead. He first described the methods of research he had used, and then went on to speak of the results he had obtained.

Speaking generally, a power of 650 linear is about ten times that previously employed, which is, of course, enough to open out a new field for research. This great increase has, however, shown little or nothing more in the case of malleable iron containing little or no carbon, or in the case of the intensely hard constituent of spiegel iron, of white refined iron, and of blister steel. It has also shown but little more in the case of enclosed slags, or of the graphite in cast iron; but it had enabled him to see to great perfection crystals which are probably silicon, and has thrown a flood of light on the nature and character of that constituent of steel which in his lecture at the last annual meeting he described as the pearly compound. High powers show that it really has a structure closely resembling that of pearl, the surface being marked by fine straight or curved parallel lines, due to the presence of alternating very thin plates of varying hardness. After only a few hours of observation, he felt almost certain that these thin plates were iron free from carbon, and the intensely hard substance seen so well in blister steel; but the facts were so extraordinary, and so unlike anything he had ever seen or heard of in any mineral substance, that it was not until after several months devoted to the careful study of all the chief kinds of iron and steel that he felt confidence in the results. The chief facts are best seen in the case of an ingot of steel of medium temper. On fracture, comparatively large crystals are visible, radiating from the surface to the interior. When a properly prepared microscopical section is viewed with a moderate power, it is easy to see that, after having crystallised out from fusion at a high temperature, these large crystals break up on further cooling into much smaller, as described in his lecture. What is now seen with very high powers is that these smaller crystals finally split up into alternating very thin plates. Taking all the facts into consideration, it appears as though a stable compound of iron with a small amount of carbon exists at a high temperature, which at a lower breaks up into iron combined with a larger amount of carbon, and into iron free from it. If these two products had not differed so much in hardness, or if the alternating plates had been considerably thinner, or if definite plates had not been formed, such a compound structure would never have been suspected. It has probably never been specially looked for in other substances, and might exist without being visible, even with the highest and best magnifying powers. To give a good idea of the size of the plates, he would refer to what is seen in a longitudinal section of medium steel forged from an ingot 3in. in diameter down to a bar 1in. square. When broken, it shows a very fine grain; and when a prepared section is examined with a moderate power, this grain is seen to be due to crystals often about one-thousandth of an inch in diameter, which are not drawn out or distorted, as they would have been if they had existed previously to final cooling after hammering, and as they are distorted if the steel be hammered at a lower temperature. Examined with a power of 650 linear, these crystals only one-thousandth of an inch in diameter are seen to contain something like sixty of the alternating plates, and even this extremely delicate structure shows little or no trace of distortion. His reason for concluding that the hard plates contain combined carbon was that they are not seen in iron free from carbon; they increase in amount with increase of carbon, and are seen to the greatest perfection when there is a considerable amount in a combined state. The relations of this unstable compound to all the different kinds of iron and steel were too complex to be described now, but he might say that when no graphite is present, a long-continued moderately high temperature may cause the two constituents to segregate into comparatively thick and irregular plates of the hard compound and aggregations of free iron; whereas when graphite is present, the combined carbon appears to be set free, crystallising out as graphite and leaving free iron. This is one of the most important differences between steel and cast iron. It also seems that this remarkable constituent probably plays the chief part in the hardening of steel. What he had been able to see with high powers shows that when strongly re-heated the constituents again combine, and when suddenly chilled there is no evidence that they separate, though it is possible that this may be because the particles are too small to be separately defined. It, however, seemed to him very probable that in the hardening process the unstable compound may not break up into soft iron and the very hard and brittle substance, but may be suddenly fixed, so as to give great hardness combined with strength. According to this view, the peculiar properties of Mushet's self-hardening steel may be due to the presence of tungsten preventing this usual separation. That the softening of hardened steel depends on a separation of the two constituents seems proved by what is easily seen when the heat has been maintained for a considerable time.

This lecture seemed to be quite over the heads of Dr. Sorby's very small audience, and no attempt was made to discuss it. Sir Henry Bessemer, however, stated that twelve years ago he tried an experiment by heating an ingot of steel to a high temperature and allowing it to cool very slowly, for ten days; at the end of that time, although 17in. in diameter, it was easily broken in two with a sledge hammer. Its structure was coarsely crystalline, the crystals measuring from a quarter to three-eighths of an inch on the side. With a light hammer these crystals could be knocked off in showers, they were so loosely held together. But tested on the anvil each crystal was found to be quite tough, flatting out under the hammer as thin as a sixpence. There was a strict analogy between the behaviour of sugar and iron. If we want small crystals of sugar, then the syrup must be cooled quickly and stirred constantly; on the contrary, when sugar candy is wanted, the syrup is kept hot for thirty hours and quite at rest. The time of cooling and the heat of the mould had a powerful influence on the grain of cast metal. The whole subject required further investigation.

The next paper read was a very short one by Mr. F. W. Webb, of Crewe, on

THE ENDURANCE OF STEEL RAILS.

This referred to a diagram showing the comparative numbers of tons of iron and steel rails used for relaying purposes on the London and North-Western Railway from 1867 to the end of this year, the last year being, of course, the estimated requirements. On the same diagram was shown the quantity of coal burnt yearly in the locomotives, as the author takes it that this is the only trustworthy way in which we can arrive at the amount of work done on the line in each year; and, as a check upon the coal consumption, he also showed on the diagram a line representing the train miles along with the engine miles, and it would be seen at a glance that while the coal line very closely follows in proportion to the train miles and the engine miles run in each year, the quantity of rails used for renewals has been a constantly decreasing amount since 1877. From 1868 to 1877 they were putting down both iron and steel rails on renewal account. It will be noticed that in 1868 the quantity of iron and steel rails required for renewals was, roundly, 16,400 tons, and that the largest weight of rails required for renewals was arrived at in 1876, twelve months after which iron rails entirely disappeared—the total number of tons used in that year, 1876, being 31,391, while the estimated requirements for this year are only 11,600 tons. Practically the whole of the main lines are relaid with steel; and while, in past years, they have been putting down steel rails as fast as iron ones wore out, they are now putting down steel rails as fast as steel rails wear out, except on some branches, where iron rails, of course, last a much longer time than on the main line. From what he could see by watching closely, he believed they had now reached the minimum required for renewals, and that the renewals will rather increase than otherwise, but at a much less rapid ratio than they did up to 1876. The small quantity of rails required for renewals on the London and North-Western Railway, if other companies have relaid their roads with steel at anything like the same rate, will account in some measure for the depression in the steel rail trade; and as the steel rails wear out, the quantity of pig iron required to keep the road going will be represented as nearly as may be by the difference in weight between the rails when put down and when taken up for renewal, plus 7½ per cent. for loss in re-manufacture. This will also represent very closely the quantity of iron required for the bath in the Siemens' furnace for re-melting the old steel rails, so that, for a considerable period, the quantity of iron required on such a line will be much less than it has been during the past period; but, if steel sleepers are found to answer, and the author saw no reason why they should not, he hoped they would, in a great measure, fill up the want of orders for steel rails in our various large works. On the main line, up to the present time, they had put down 45,000 steel sleepers, and, on recently examining those first put down on the Chester and Holyhead line six years ago, he found they were in very good order, with no signs of loose rivets, though these sleepers were made with a much less chair base and leverage for the rivets than those they are making now. There was no discussion.

A paper by Mr. F. Gautier was then read

ON A NEUTRAL LINING FOR METALLURGICAL FURNACES.

The object of this paper was to call attention to a refractory material which is not acid, nor basic, nor reducing, nor oxidising, but which, when properly employed, may be very useful for furnace linings. Chrome iron is a chemical combination of oxide of chrome and protoxide of iron—Fe O, Ce² O³. Chemically speaking, chrome ore is very hard to dissolve. Acids have no action upon it; potash and soda alone can smelt it, with the assistance of a high-grade oxidising action, and converts it into alkaline chromates or bichromates. Carbon has, at a high temperature, a reducing action on the chrome ore, and the result is an alloy of iron, chrome, and carbon, now practically employed, especially on the Continent, under the name of ferrochrome, in order to impart to steel the important properties of hardness and toughness. A piece of chrome ore remains, with its sharp edges, floating on the bath of melted steel in a Siemens furnace, without any alteration. From a physical point of view, chrome ore is essentially refractory. Heated in lumps it does not crumble to pieces, however high the temperature. In general metallurgy, where no alkalies in notable quantities are present, chrome iron is a refractory material of a specially neutral character, since neither acids nor bases act upon it. The first trial of the chrome ore in a natural state as a refractory material was made in 1879 by M. Pourcel. This was followed in 1880 by its employment on a large scale at the Petersbourg-Alexandrofsky Steel Works, which were under the technical superintendence of the Terre-Noire engineers. In the basic open-heath process the chamber is always composed of dinas or silica bricks, whereas the walls of the furnace must be basic. The result is that a critical point is found at the contact between the acid and the basic material. This difficulty was overcome by introducing at that point blocks of chrome iron. A new use of chrome ore in metallurgy was found by MM. Valton and Remaury, and is now adopted in practice. It is the consequence of the chemical inertia of chrome iron in contact with the smelted metallic materials or silicates. Since chrome iron is highly refractory, and cannot be smelted by silica, why could it not be a constituent material of the furnace hearth and walls? The prime cost of this substance, though relatively high—about £4 a ton—does not interfere at all, since the wear and tear is trifling. We thus realise a kind of crucible which plays about the same part that platinum does in laboratories. The chrome iron is employed in two shapes —in lumps, and in mortar with lime. In lumps, chrome iron, in its natural state, is without distinct crystallisation and very hard; it can, however, be cut easily enough to be shaped for masonry purposes. In open-hearth practice lumps of chrome iron are employed with a lime cement, together with some other description of walls, for the smelting of wrought iron scrap mixed with pig iron, or of wrought iron and iron ore. The result is a very soft steel, and, according to M. Deshayes, the manager of the Tamaris Steel Works in France, these steels are softer than their carbon percentage would at first sight indicate. Amongst the works where such open-hearth practice with chrome iron is carried on in France are—Commercy, Meuse; Blagny, Ardennes; Morvillars, Territoire de Belfort; Tamaris, Gard.

The discussion which ensued was brief and of small importance. Mr. Windsor Richards said that chrome ore had been tried years ago in making basic steel. The difficulty was that it was very hard to get, but it answered admirably. Mr. Pochin, however, had stated that he believed he could get it now in blocks of sufficient size. A lining of chrome ore would easily last six months. Mr. Riley, of the Steel Works of Scotland, said he had a similar experience. Tar is used to make the bricks, not lime. Professor Huntingdon said that he had experimented with chrome ore, and found that it could be fluxed, if intensely heated with silica, provided oxygen enough was present to convert it into chromic acid; but in a furnace there was no oxygen available, hence its refractory property. M. Gautier, in replying, produced a species of chrome ore, which freely scratched glass. He stated that a lining of it 8in. or 10in. thick was sufficient.

Mr. Turner, demonstrator of chemistry, Mason College, then read in abstract a very long and valuable paper on

THE CONSTITUENTS OF CAST IRON.

The most important feature in this paper was the announcement that it was possible, without any extra expense, to impart to all cast iron a tensile strength of at least 15 tons per square inch, or nearly double that on which it is now safe to reckon. In order to do this it is only necessary to have sufficient silicon in the metal. The author's own experiments were made with iron of more than usual puri y specially prepared by heating South Staffordshire wrought iron in crucibles with charcoal. The product was then mixed with various amounts of silicon pig, and the resulting metal examined chemically and mechanically. The materials employed had the following composition:—

Description.	T· tal cart on.	Graphite.	Si.	P.	Mn.	S.
Original cast iron	1·98	0 38	0·19	0·32	0·14	0 05
Silicon pig	1·81	1·12	9·80	0·21	1·95	0·04

The total carbon was purposely kept as nearly as possible constant at 2 per cent., so as to obviate any uncertainty due to variations in that element. The only element other than silicon which varied to any considerable extent was manganese; but in this case the alterations were rather less than one-fifth of the variations in silicon, and would not appear to have introduced an appreciable error. In the table annexed the results of his experiments are collected together for the first time. In addition to what has been previously published, there is added a specimen containing 1·4 per cent. of silicon, as that appeared from his earlier experiments to be of considerable interest. There is also given the calculated transverse strength, which is of importance in connecting together tensile and crushing strength. The tensile and crushing tests were performed by Professor A. B. W. Kennedy, of University College, London; while he was indebted to Mr. J. P. Walton for assistance in the analytical part of the work.

TABLE A.—*Effect of Silicon on the Properties of Cast Iron.*

Silicon, per cent. (calculated).	Relative density at 20° C. (Water at 20° = 1.)		Relative hardness.	Tensile strength = per square inch.		Modulus of elasticity.	Crushing strength per square inch.		Calculated transverse strength. Bars 1ft. long, 1in. square, loaded in the centre.		Chemical analysis.						
	Cylinders.	Turnings.		lbs.	tons.		lbs.	tons.	lbs.	tons.	Total carbon.	Graphite.	Combined carbon.	Silicon.	Phosphorus.	Manganese.	Sulphur.
0	7·560	7·719	72	22,720	10·14	25,790,000	168,700	75·30	2702	1·206	1·98	0·38	1·60	0·19	0·32	0·14	0·05
0·5	7·510*	7·670	52	27,580	12·31	28,670,000	204,800	91·42	3280	1·464	2·00	0·10	1·90	0·45	0·33	0·21	0·05
1	7·641	7·630	42	28,490	12·72	31,180,000	207,300	92·54	3370	1·504	2·09	0·24	1·85	0·96	0·33	0·26	0·04
1·4	7·555	7·473	—	31,440	14·04	23,500,000	183,900	82·08	3498	1·561	2·21	0·50	1·71	1·37	0·30	—	0·05
2	7·518	7·350	22	35,180	15·70	23,560,000	137,300	61·29	3446	1·538	2·18	1·62	0·56	1·96	0·28	0·60	0·03
2·5	7·422	7·388	22	32,760	14·62	25,450,000	172,900†	77·18†	3534†	1·577†	1·87	1·19	0·68	2·51	0·26	0·75	0·05
3	7·258	7·279	22	27,390	12·23	21,150,000	128,700	57·45	2850	1·272	2·23	1·43	0·80	2·96	0·34	0·70	0·04
4	7·183	7·218	27	25,280	11·28	15,640,000	106,900	47·74	2543	1·135	2·01	1·81	0·20	3·92	0·33	0·84	0·03
5	7·167	7·170	32	22,750	10·16	18,720,000	103,400	46·16	2342	1·046	2·03	1·66	0·37	4·74	0·30	0·95	0·05
7·5	7·128	7·138	42	11,950	5·34	14,750,000	111,000	49·55	1505	0·672	1·86	1·48	0·38	7·33	0·29	1·36	0·08
10	6·978	6·924	57	10,630	4·75	13,930,000	76,380	34·10	1252	0·559	1·81	1·12	0·69	9·80	0·21	1·95	0·04

* This number is rather low, as the specimen afterwards proved to be somewhat faulty.
† The value in this case is probably exceptionally high; a crushing strength of about 60 tons might be anticipated from its position in the series.

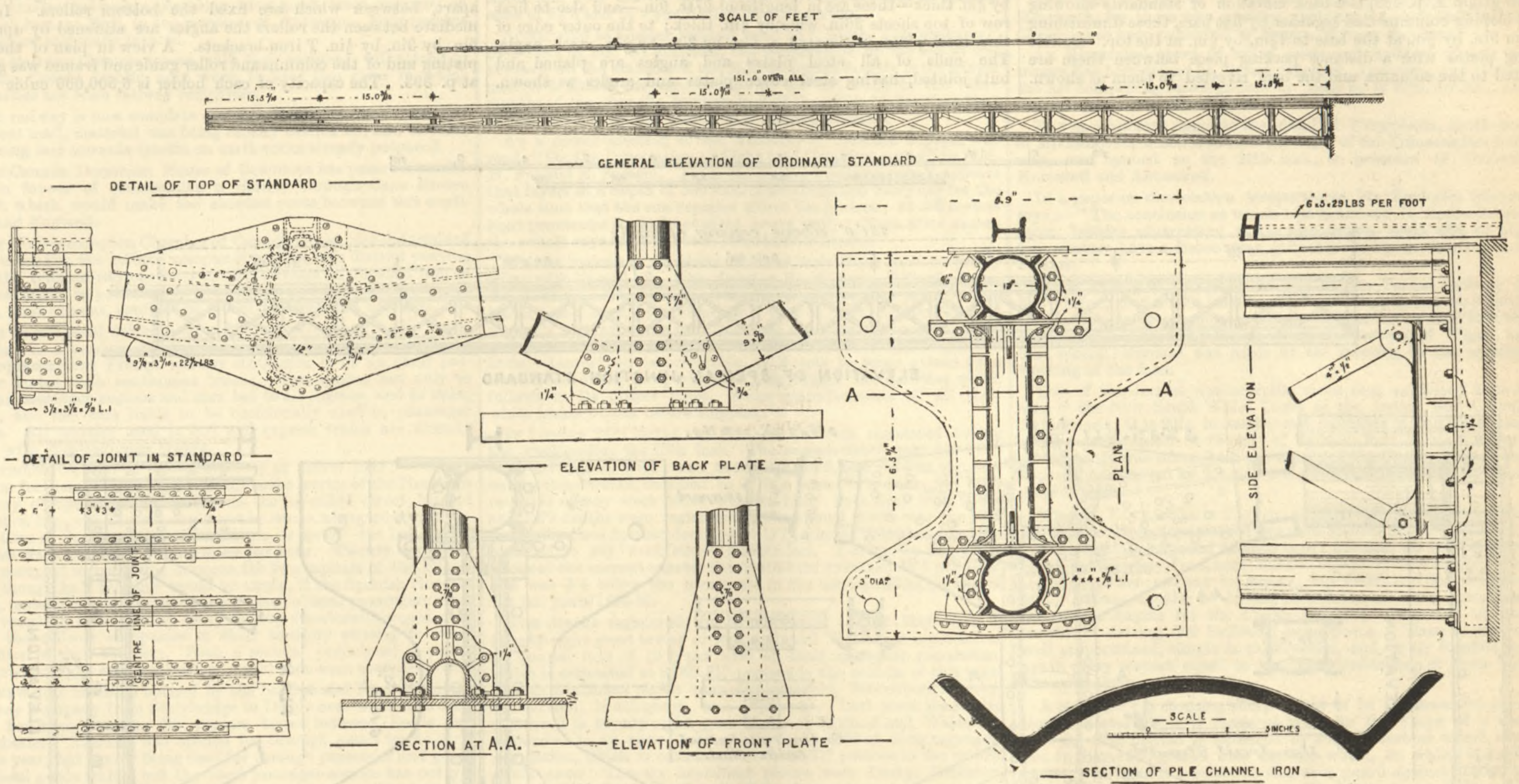
The tensile strength will be seen to vary with remarkable uniformity, attaining a maximum of 15·7 tons, with two per cent. of silicon. This is an unusually high value for cast iron, though it has been exceeded by the American experimenters with 20·5 tons, and very nearly approached in the Woolwich experiments of 1858 with 15·3 tons. The author believed that, starting with good materials, by careful mixing, a tensile strength of 15 tons per square inch, as measured by bars one inch in diameter, could be regularly assured. In modulus of elasticity a maximum value is obtained with one per cent of silicon. In the first seven members of the series exceptionally high values are obtained, which are probably connected with the low percentage of total carbon.

The crushing strength also shows a very considerable uniformity, the only exception being the 2·5 per cent. specimen, which is probably rather too high, owing to the small amount of graphitic carbon. The maximum value of 92·54 tons was obtained with one per cent. of silicon. This value, though greater than is usual with cast iron, has been exceeded by Sir W. Fairbairn, who in 1853 recorded a crushing strength of nearly 96 tons.

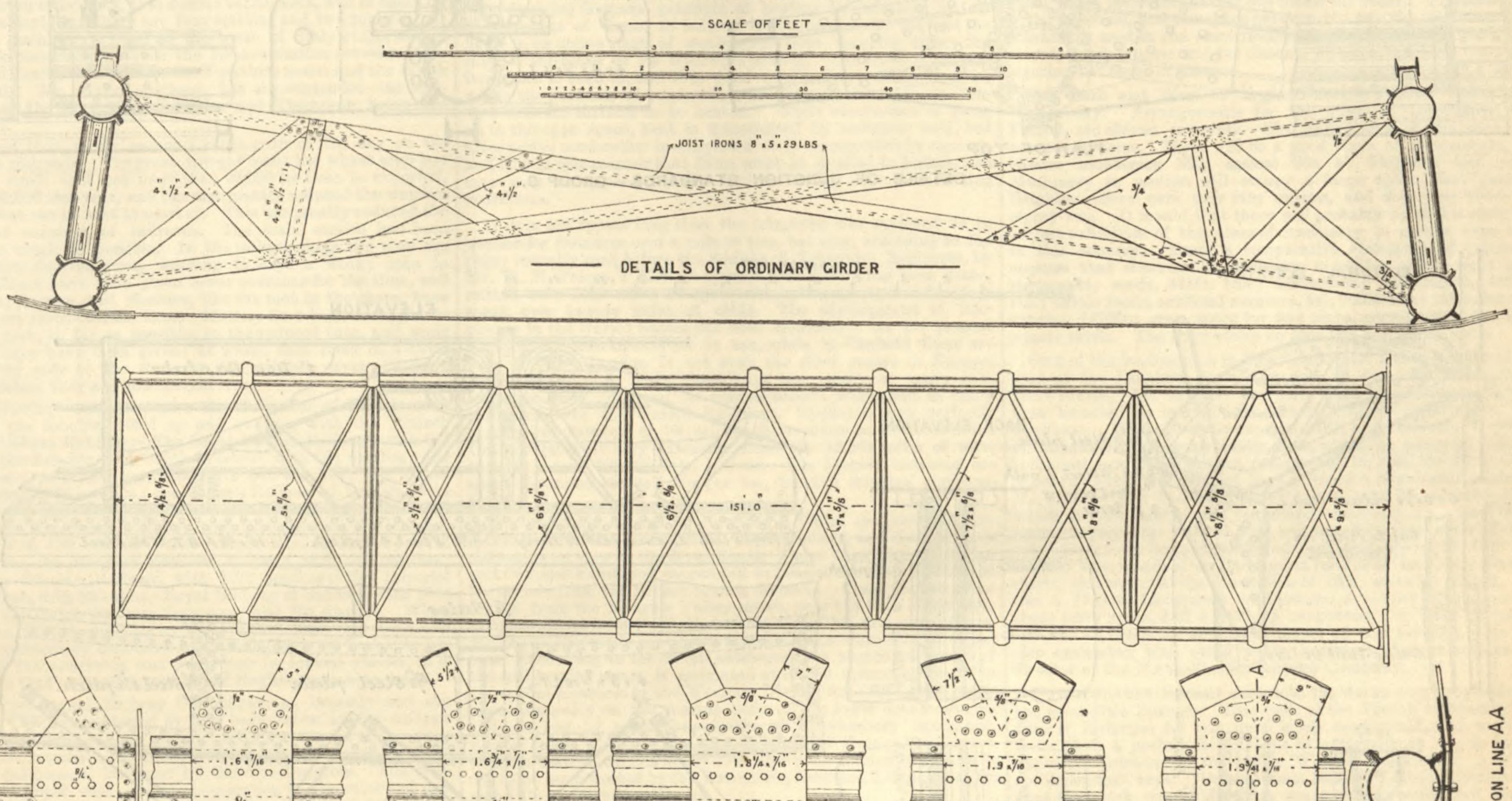
The author concluded—(1) That pure cast iron, *i.e.*, iron and carbon only, even if obtainable, would not be the most suitable material for use in the foundry. (2) That cast iron containing excessive amounts of other constituents is equally unsuited for foundry purposes. (3) That the ill effects of an excess of one constituent can at best be only

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

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

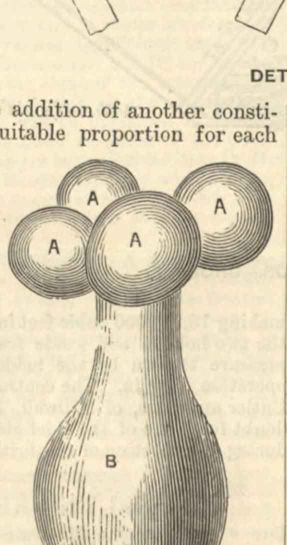


DETAILS OF STANDARDS.—GROUP I.



DETAILS OF STANDARDS AND CONNECTING GIRDERS.—GROUP 2.

imperfectly neutralised by the addition of another constituent. (4) That there is a suitable proportion for each constituent present in cast iron. This proportion depends upon the character of the product which is desired, and upon the proportion of other elements present. (5) That variations in the proportion of silicon afford a trustworthy and inexpensive means of producing a cast iron of any required mechanical character which is possible with the material employed.



INDIAN CLAY MOULD.

The discussion on this paper was carried on principally by Professor Huntingdon and Mr. Bauerman, but it added very little to what the author had said, and did not contradict his statements. Mr. Bauerman referred to cast iron shown in the Antwerp Exhibition last year which had a tensile strength of 26 tons per square inch.

We referred last week to an Indian anklet resembling a curb chain cast in one piece. A short paper was read describing this process, which paper will be found in full in another page. The author exhibited one of the moulds, which closely resembles the annexed sketch. The moulds of the objects to be cast are enclosed in the clay knobs A A A A. The crucible containing the metal to be cast is shut up in the clay at B. The whole is heated white hot in the position shown; then it is taken out of the furnace and turned upside down, when the metal runs into the moulds, as described in Mr. Clark's paper.

This concluded the business of the meeting, which terminated about half-past one p.m. Dr. Percy announced that the next meeting would be held in London, at a date not yet fixed. Votes of thanks were passed to him, and to the Institution of Civil Engineers for the use of the hall.

The meeting was very thinly attended throughout, and on Friday the members present spent most of their time on the stair landings, or in the library, conversing with each other—anywhere and anyhow, indeed, rather than in the hall listening to papers or discussing them. In fact, the interest taken in the proceedings was as languid as it could possibly be.

NAVAL ENGINEER APPOINTMENTS.—The following appointment has been made at the Admiralty:—Henry E. Wingfield engineer, to the Porpoise.

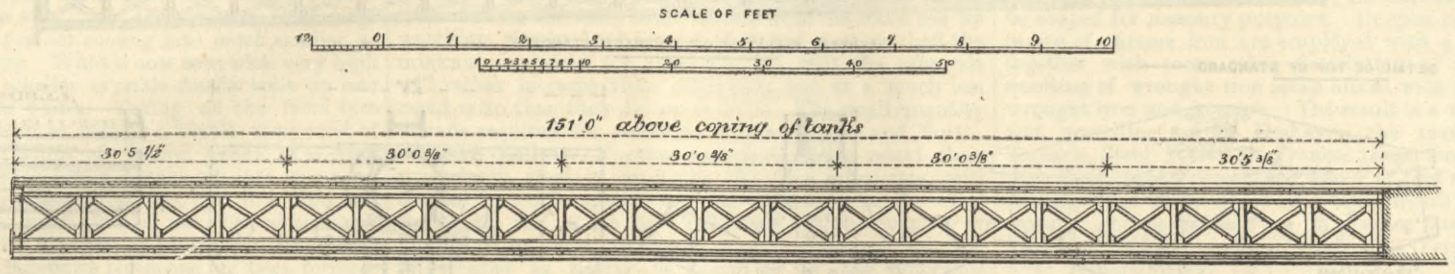
THE GREAT GASHOLDERS, BIRMINGHAM GAS WORKS.

IN our present number we give illustrations of the two three-lift gasholders recently erected from the designs of Mr. Charles Hunt, M. Inst. C. E., for the borough of Birmingham, at the Windsor-street Works. Group 1, above, shows elevation and details of connections of the standards. Each standard consists of two columns, 12in. in diameter, connected together by cast iron struts. The columns are 5ft. apart, centre to centre, at the base; the front column to which the roller guide is attached rising vertically to 151ft. in height, the back columns sloping inwards till they meet at the top, where they are connected by angle brackets to a large cover plate, to which also are rivetted the top girders. The columns are constructed of pile channel iron $\frac{3}{8}$in. thick—four sections forming the circle—with external flanges rivetted together with $\frac{3}{4}$in. rivets 6in. pitch. They are formed in. 30ft. lengths, and jointed with steel cover strips, steel rivets being used for this purpose, each section of the channel iron breaking joint as shown. The standards are secured to the cast iron bases by angle irons and flanged gusset plating bolted to the bases with $1\frac{1}{4}$in. bolts. The cast iron struts—shown at the lower right-hand of group 7, to appear in our next—between the columns are placed 7ft. 6in. apart, and are connected to each other by 4in. by $\frac{1}{2}$in. diagonal bracing. The standards are connected together at four points in their height by girders formed of two 8in. by 5in. joists shown in group 2, above. These joists cross each other and connect the front column of one standard to the back column of the next; they are rivetted together at the centre, and stiffened by 4in. by 2in. by ½in. tees and 4in. by ½in. flat ties. The standards are tied together at the top by girders formed of two channels 9⅝in. by 3$\frac{3}{16}$in., to which is rivetted a 16in. by $\frac{5}{16}$in. plate. To this p'ate are fixed hand-rails and standards, forming a footway round the top.

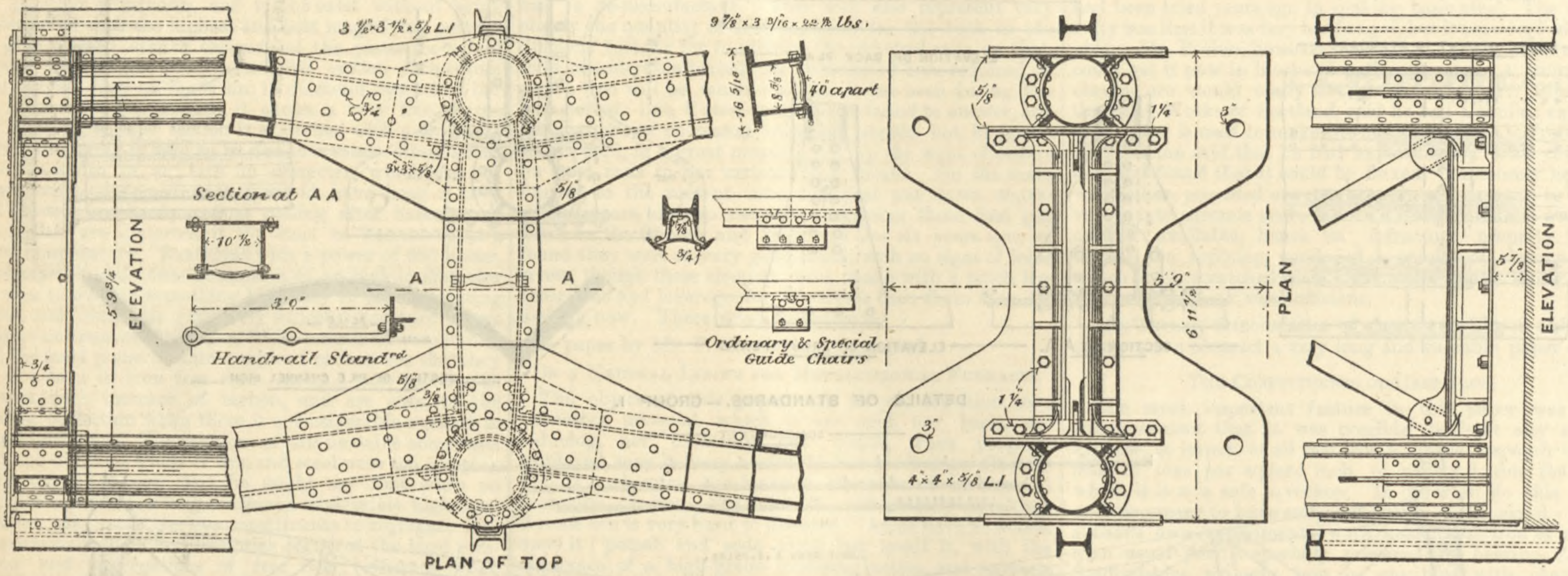
In group 2, p. 409, is a back elevation of standards showing the sloping columns tied together by flat bars, these diminishing from 9in. by ⅝in. at the base to 4½in. by ⅝in. at the top. Double wing plates with a distance packing piece between them are bolted to the columns, and the bars rivetted to them as shown.

vertical stiffening booms is also on plate 4. The construction of the inner holder, diameter 230ft., depth 50ft., rise of crown 20ft., is shown in group 5 below. The top kerb is formed of steel. The obtuse angle 6in. by 6in. by ⅝in. is double rivetted, with ⅝in. steel rivets to the top row of side plates 14in. deep by ⅜in. thick—these are in lengths of 27ft. 9in.—and also to first row of top sheets 36in. wide by ⅜in. thick; to the outer edge of this steel plate is rivetted a 5in. by 3in. by ⅝in. steel angle. The ends of all steel plates and angles are planed and butt-jointed, having steel cover plates and angles as shown.

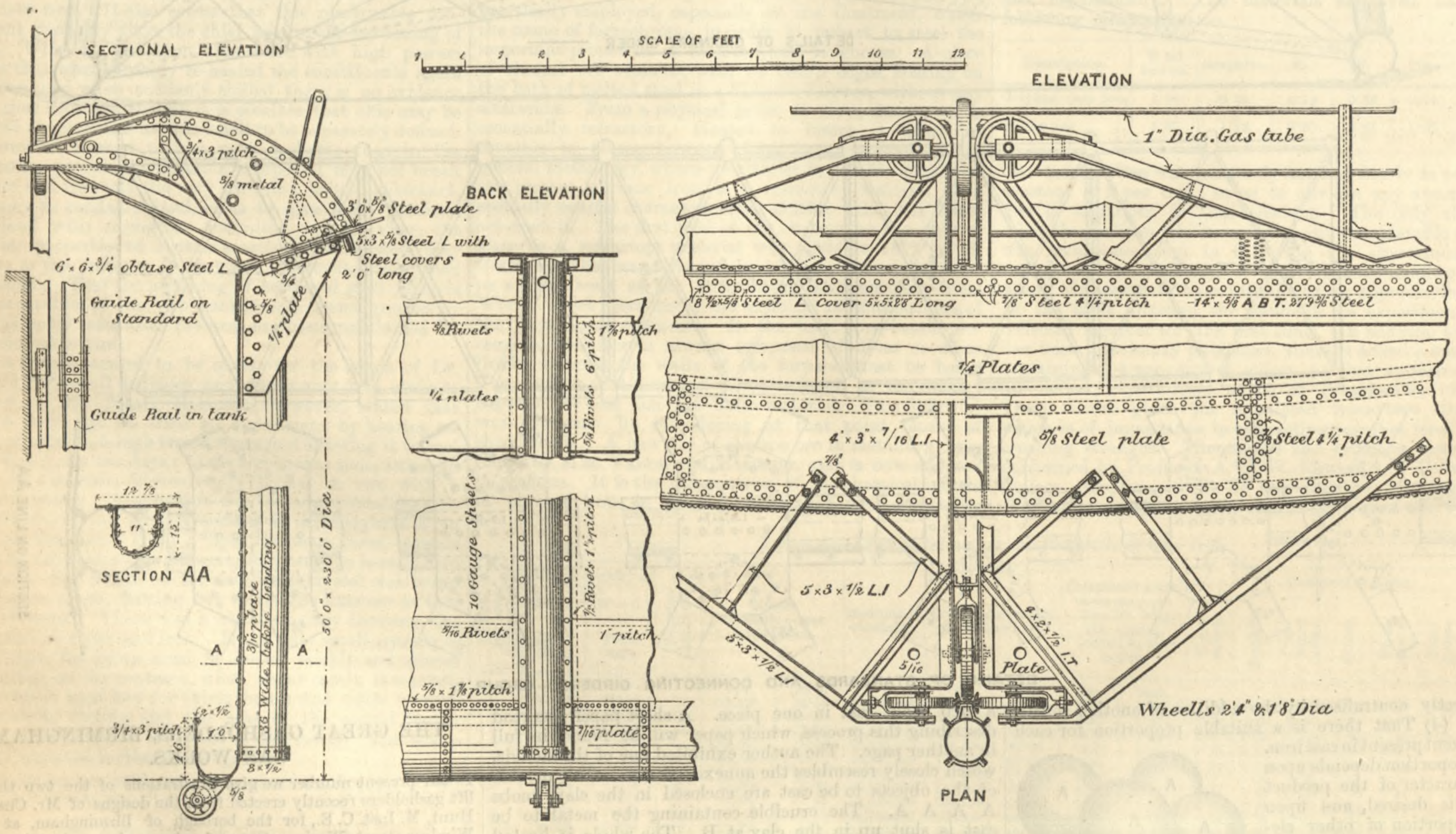
bottom rollers of inner lift work—the channel iron thus forming part of the boom and adding additional stiffness to it. The details of outer lift, 236ft. diameter, will be given in Group 7. The bottom kerb consists of a plate 24in. deep, $\frac{7}{16}$in. thick, to which are rivetted two 9in. by 3½in. by $\frac{7}{16}$in. angles, 15in. apart, between which are fixed the bottom rollers. Intermediate between the rollers the angles are stiffened by upright 6in. by 3in. by ½in. T iron brackets. A view in plan of the top plating and of the columns and roller guide and frames was given at p. 393. The capacity of each holder is 6,500,000 cubic feet,



ELEVATION OF SPECIAL JUNCTION STANDARD



DETAILS OF JUNCTION STANDARDS.—GROUP 3.



PLAN AND ELEVATIONS OF TOP GIRDERS, GUIDE ROLLERS, AND FIXINGS.—GROUP 5.

Group 3 above shows the elevation of the standard that is situated at the junction of the two holders and is common to both, making the twenty-sixth standard round each; its construction is similar to the ordinary standards, with the exception that both columns are vertical and each provided with a roller guide. The two vertical columns are connected at the top by a girder formed of channel irons and a top plate, and serves as a footway from one holder to the other. It is claimed for this arrangement of guide framing that with economy of material and simplicity of erection great rigidity of structure is obtained. Both during and after erection the framing has been severely tested by heavy gales, with the result that no perceptible vibration is noticed. An elevation of ladder leading to the top of standards with platforms on each girder was shown in group 4, p. 393. A projecting landing fixed on the kerb of inner holder opposite the ladders affords means of access to the top of holder at any height it may be at. A part elevation of holder at its full height, showing arrangement of side sheets with the

The kerb is further stiffened at fifty-two points in the circumference by ¼in. gusset plates bolted to each side of vertical booms and to top plates. The second and bottom rows of side sheets are of ¼in. iron, the intermediate are No. 10 gauge. The sheets are larger than those generally used, measuring 6ft. 6in. by 3ft. 3in., thus dispensing with a considerable amount of jointing. The vertical booms are bent out of $\frac{5}{16}$in. plates and rivetted to a strip 18in. by ½in. The top guide carriages of this and also the intermediate and outer lifts are fitted with radial and tangential pulleys; these, by means of adjusting screws, can be fixed to suit any inequality of the guides. All the cups and grips, formed out of $\frac{7}{16}$in. plates, are 18in. deep by 12in. wide.

Group 6, which will appear in another impression, gives part elevations and section of intermediate lift, 233ft. diameter. The vertical booms project from the sides of holder four inches, the bent plate being rivetted to an 18in. by ½in. strip, to which, by means of angle brackets about 5ft. apart is fixed a channel iron guide—in which the

making 13,000,000 cubic feet in all. The total weight of iron in the two holders and guide framings is about 3250 tons. The pressure thrown by the holders when the three lifts are in operation is 8$\frac{3}{10}$in. The contractors for the work were Messrs. Cutler and Sons, of Millwall, London. These holders will no doubt form one of the chief attractions of engineering interest during the meeting of the British Association in September.

WINDING ENGINES FOR AUSTRALIA.

THE winding engine illustrated by the engraving on page 416 has been constructed by Messrs. Tangye, Birmingham, under the instructions of Mr. J. D. Baldry, M.I.C.E., for the Australian Agricultural and Mining Company, New South Wales. On a previous occasion we illustrated some machinery of a similar character sent out by the same makers to Australia, and in another impression we shall publish some detail engravings and particulars of the engines now illustrated.

RAILWAY MATTERS.

The Railway Committee of the Paris Chamber has resolved on sending some of its members to London to study the working of the Metropolitan Railway.

A collision between a passenger and a goods train occurred on the 24th inst. at Mall, in the province of Antwerp. Four persons were killed and many injured.

The Railway Commissioners, with their registrar, will attend at the Four Courts, Dublin, next week, to hear two cases in which the parties are Irish railway companies.

The railway is now complete through the Bolan Pass. At date of recent mail, material was being rapidly carried up, and the line was being laid towards Quetta on earthworks already prepared.

The Canada Dominion House of Commons has passed a resolution in favour of constructing a railway through Cape Breton Island, which would make the shortest route between this continent and England.

The Wolverhampton Chamber of Commerce has just determined to memorialise the railway companies serving this district praying that the reduced railway rates on the carriage of finished iron to London might be extended to two-ton lots and upwards, instead of being, as at present, confined to lots of ten tons and upwards.

The recent fatal collision near Monte Carlo brought the brake question to a head in France. The Minister of Public Works has requested the French railway companies to fit up their passenger trains with continuous brakes. This applies not only to regular passenger engines and cars but to all engines, and to milk, horse, and fish cars liable to be occasionally used in passenger trains. All vehicles used in fast and express trains are already fitted with Westinghouse brakes.

A correspondent of a contemporary at Lisbon says:—"There is room for considerable improvement in the service of the Northern Railway of Spain. The service on the so-called direct Madrid to Lisbon line, *viâ* Caceres, could not be worse, as regards organisation, time of starting, stations, carriages, or speed—the last for an express train averaging twenty miles per hour. Twenty-one hours were occupied in travelling between the two capitals of the Peninsula, though half the time would be ample, if the Spanish Government, instead of being intimidated by the political passengers who, unfortunately, form part of every railway directorate, would only keep the railway companies in their territory strictly to every condition of their charters. Such a scandal, prejudicial to public and international communication, would then soon cease to exist."

A new line has been opened by the London and North-Western Railway Company from Stalybridge to Diggle over which the company has been running its express trains between Leeds and Manchester. The line was opened for through goods traffic early in the year, but is now being used for through passenger and goods and local goods traffic, but the local passenger service has not yet been started, because all the stations are not ready. The new line is nearly seven miles long, it is double throughout, and is made on a steep gradient, and there are four stations and two tunnels. It leaves the main line a little to the north of Stalybridge, and is expected to materially improve the communication between Manchester and Leeds, and between the Yorkshire towns and the South of England. Mr. Buck, engineer, has superintended the construction of the line, Messrs. Taylor and Thompson being the contractors.

It is said that severe economy is the order of the day on the Australian railroads. The great drought made the wheat crop last winter so small that not more than 50,000 tons can be exported, against 300,000 last year, and has also greatly reduced the number of cattle that can be sent to market. This has greatly reduced the traffic and earnings of railroads. The train service has been reduced as much as possible. In the railway shops the men are put on three-fourths time, working $4\frac{1}{2}$ days a week; men in superior places have been given lower positions for the time, and enginemen, firemen, and cleaners, like the men in the shops, have been put on three-fourths time. Matters have been arranged to keep the men, so far as possible, on the reduced time, and some new privileges have been given; as where men lived in a town whence they rode to the shops on the railroad, paying 9s. for a monthly ticket, they are now carried free.

The following companies have the distinction of having more than 500 gas coaches fitted up and running with the Pintsch system of oil-gas lighting:—The Great Eastern Railway, with 621 coaches; the London and South-Western, with 761 coaches; the Paris, Lyons, and Mediterrannée, with 602 coaches; the Lower Silesian, with 1029 coaches; the Eastern Railway of Prussia, with 804 coaches; the Magdeburg-Halberstadt Railway, with 1053 coaches; the Hanoverian Railway, with 1219 coaches; the Rhenish Railway, with 838 coaches; the Cologne-Minden Railway, with 604 coaches; the Bergisch-Markisch Railway, with 980 coaches; the Upper Silesian Railway, with 1072 coaches; the Imperial German Post, with 800 vans; Royal Railway of Saxony, with 1024 coaches; the Dutch Railway Company, with 569 coaches. When it is known that the lighting by these means costs very much less than the barbarously inefficient and troublesome oil lamps, to say nothing of the enormous cost every year for broken glasses, it is remarkable that so small a quantity of English stock is so fitted.

The International Railway Commission at Brussels and the Executive Committee elected by that body—of which Sir Andrew Fairbairn is a member—are making arrangements for the meeting of the new International Railway Congress, which is to continue the work commenced last year by the first Congress. The committee is charged with—(1) the preparation of the rules and programme of the next Congress; (2) the organisation of future railway congresses; (3) the compilation of technical railway statistics; (4) correspondence with the various railway administrations, with a view to an agreement as to the questions to be examined by the Congress; (5) the arrangement of information which may interest the Congress, and the formation of a library of works of reference; (6) the preparation of a history of various experiments made; (7) the keeping of the accounts of the Commission; and (8) the issuing of a publication which is to serve as the organ of the International Commission. This publication is to contain all the reports preparatory to the next Congress, and will be published in French either monthly or quarterly. The financial resources of the Commission and of the committee, which are both presided over by M. Fassiaux, Secretary-General of the Belgian Ministry of Railways, Posts, and Telegraphs, consist of an annual subsidy of 5000f. from the Belgian Government, and of contributions paid by certain State and private railways.

More railways are proposed in Nova Scotia. A dispatch from Halifax, N.S., May 4, says: "The Government railroad scheme was submitted to the Legislature to-day. The Maine Central syndicate and all other Canadian and American schemes are rejected, and the offer of the joint stock association of London is accepted. The main propositions are that the Government will acquire and transfer to this company the Windsor and Annapolis and the Western Counties railroads, and obtain a transfer of the Windsor Branch from the Dominion Government. The new company is to construct the missing link between Digby and Annapolis, and will thus have a through line from Yarmouth to Halifax, with steamer connections with Boston at each end of the province. The Government undertakes to guarantee 2,000,000 dols. interest on the company's debentures for twenty years, and to make up any deficiency in earnings below a stated amount. This company will also have the option of acquiring the Nictaux and Atlantic road, now being constructed by Americans, and to build roads from Yarmouth to Shelburne and Windsor to Truro. The Government also proposes to give a subsidy of 3200 dols. and 2800 acres of crown lands per mile in addition to the Dominion subsidy to the road between the Straits of Canso and Sydney or Louisburg, and also give 3200 dols. and 2000 acres of land per mile to any company building any railroad in Nova Scotia."

NOTES AND MEMORANDA.

In Greater London during the week ending the 15th inst., 3132 births and 1731 deaths were registered. The annual rates were 30·8 and 17·0 per 1000. Last week in Greater London 3486 births and 1717 deaths were registered, corresponding to annual rates of 34·3 and 16·9 per 1000 of the population.

According to a paper recently read on "Earth Temperatures," 1881-1885, by Mr. W. Marriott, the temperature of the soil at 1ft. at nearly all the stations of the Meteorological Society in the winter months is almost the same as that of the air, while in the other months of the year the temperature of the soil is higher than that of the air at all except that of the London stations.

At a recent meeting of the Academy of Sciences a paper was read, "On the Penetration of Light into Deep Sea-water," by MM. H. Fol and E. Sarasin. From the author's experiments it appears that layers at a depth of 300 metres are illumined every day for the whole time that the sun remains above the horizon; at 350 metres light penetrates for at least eight hours daily. Even after sunset the actinic rays seem to reach considerable depths.

Wagon makers or repairers can save their stock from worms by oiling with linseed oil. The *Lumber World* says: "Single trees, double trees, neck yokes, spokes, and cross bars that are of white hickory, and are kept in stock for a year or more, will be eaten by worms if not kept in a dark place or otherwise protected. Coal and kerosene oil are good also, and the expense of applying is but little. Linseed oil is preferable, as it acts to some extent as a wood filler, filling the pores, and thus aiding the painting which follows in its proper place. Some manufacturers oil all their white hickory stock before shipping."

In London 2424 births and 1414 deaths were registered during the week ending the 15th inst. The annual-death rate per 1000 from all causes, which had been 18·4, 18·5, and 18·7 in the preceding three weeks, declined to 17·8, a lower rate than has been recorded in any week since October last. Last week 2690 births and 1379 deaths were registered. The annual death-rate per 1000 from all causes further declined to 17·3, a lower rate than has been recorded in any week since October last. During the first seven weeks of the current quarter the death-rate averaged 18·6 per 1000, and was 3·4 below the mean rate in the corresponding periods of the ten years 1876-85.

The deaths registered during the week ending May 15th in twenty-eight great towns of England and Wales corresponded to an annual rate of 19·1 per 1000 of their aggregate population, which is estimated at 9,093,817 persons in the middle of this year. The six healthiest places were Huddersfield, Birkenhead, Derby, Sunderland, Nottingham, and Plymouth. Last week the deaths registered in twenty-eight great towns of England and Wales corresponded to an annual rate of 18·7 per 1000 of their aggregate population, which is estimated at 9,093,817 persons in the middle of this year. The six healthiest places were Derby, Brighton, Bristol, Hull, Sunderland, and Wolverhampton.

In applying Siemens' principle of heating by radiation, or free development of flame, to boilers, it is necessary to prevent the flame in its active stage of combustion from touching either the sides of the boiler or its brickwork setting. The flame is allowed free space to burn in, and thus good combustion is obtained, after which the products of combustion are brought into intimate contact with the surfaces to be heated. While combustion is going on in the open space, heat is transmitted by radiation only, but after active combustion is completed it is transmitted by contact, and it is in this manner that flame must be applied to boilers, and may may be applied equally well to nearly all other heating operations.

It does not appear long since the telephone was supposed to be useless for distances over a mile or two, but now, according to the paper recently read before the Society of Telegraph Engineers, by Mr. W. H. Preece, F.R.S., it appears that speech has been transmitted over 1000 miles of open wire, although it is difficult to speak over twenty miles of cable. The development of telephones in the United States has been enormous. At the present time 325,574 instruments are in use, while in England there are only 13,000. London is not even the chief centre in Europe. Berlin exceeded it, while Stockholm had nearly as many subscribers. New York and its neighbourhood alone had as many instruments as the United Kingdom. Speech is now perfectly practical to distances of 100 miles. Inter-urban connections in the United States are very extensive, from the 42,461 miles of wire, and they earn 538,000 dols. a year. The longest distances are about 100 miles, the toll 25c., or 1s., for five minutes' conversation.

The vast beds of coal of New South Wales are proving of immense value in the development of the Colony, and the numerous specimens on view in the New South Wales Court at the Indian and Colonial Exhibition cannot fail to possess considerable interest for visitors from the British mining districts. There are two cubes of coal from the Lithgow Valley mines, near the Blue Mountains, samples of coal from Bulli, Newcastle, Coal Cliff, and other places, one of the Newcastle specimens representing a seam 12ft. in thickness. According to the official catalogue, the approximate area of the coal-bearing strata is estimated at 23,950 square miles. The upper coal-measures in the Western District are 480ft. thick, resting conformably on the marine beds of the lower coal-measures, and overlaid by more than 500ft. of Hawkesbury sandstone. Eleven seams of coal have been counted in them; the lowest, which is 10ft. thick, lies about 25ft. above the marine beds, and is the same seam worked by the Bowenfels, Eskbank, Lithgow Valley, and Vale of Clwydd collieries.

In a circular note to wire and wire rope manufacturers and colliery proprietors, Mr. James B. Wilson, of Haydock, St. Helens, who claims to be the inventor of wire rope, notes that in 1832 wire rope was a new manufacture, difficult to introduce, and very difficult to sell; indeed, there was scarcely anyone who would give it a trial. About this time, however, Mr. Thomas Sherratt, of Salford Ironworks, Manchester, gave his first order for a wire rope, to lift a large engine beam. The rope was made without any twist in the individual wires. This was an event to be legitimately wondered at, as it may be at the present day, when it is borne in mind that at that time nothing was known of wire rope. It subsequently transpired that about the year 1835 Mr. Albert introduced chains, and soon after wire rope, in the royal mines in the Hartz Mountains. At the meeting of the British Association, at Newcastle-on-Tyne, in 1838, Mr. John Taylor, F.R.S., read a paper by Count Brenner, on "Wire Rope." Now, in 1886, wire rope is in general use all over the world, and has almost entirely superseded hemp rope.

The annual report of the American Iron and Steel Association just issued shows that the American production of pig iron in 1885 amounted to 4,529,869 tons, as compared with 4,589,613 net tons in 1884. The output of all descriptions of manufactured iron, including iron nails and excluding iron rails, was 1,789,711 tons, against 1,931,747 tons in 1884. The total manufacture of iron and steel rails amounted in 1885 to 1,094,215 tons, against 1,144,851 tons in 1884. The production of steel of all kinds is returned at 1,917,350 tons, as compared with 1,736,985 tons in 1884. The above figures show that the decrease in the production of iron and steel in the United States during last year was inconsiderable. The foreign trade of the States, on the contrary, suffered a serious reduction. The value of the American imports of iron and steel in 1885 was 31,945,823 dols., as compared with 38,211,800 dols. in 1884; that of the exports of iron and steel, and including agricultural implements, 19,163,066 dols., against 22,685,706 dols. in 1884. The report of the Association also gives correct figures of the construction of railways in the United States, from which it appears that the number of miles of railway completed in 1885 was 3000, bringing the total mileage of the Union open for traffic at the end of 1885 up to 128,279 miles.

MISCELLANEA.

The Belgian Society of Engineers has arranged a historical and demonstrative exhibition of various forms of lighting apparatus, to open at the Brussels Bourse this—Friday—evening, May 28th.

The first number of a monthly magazine, edited by T. C. Hepworth, for those who practice photography, and entitled the *Camera*, has been published by Messrs. Wyman and Sons.

An illustrated sheet of rolled joists and built-up girders and trusses has been issued by Messrs. Gardner, Anderson, and Clarke, the list comprising rolled girders or joists up to 22in. by 8in., and the strengths of various forms.

The new harbour opposite the island of Urzambada, south-west of Mikhailovsk, which is to form the depôt of the Transcaspian Railway, was opened on the 24th inst., in presence of Generals Komaroff and Annenkoff.

In a paper on dissociation temperatures, Mr. Frederick Siemens says:—"The conclusion at which I have arrived is, that solid surfaces, besides obstructing active combustion, must also at high temperature have a dissociating influence on the products of combustion."

In our report of the paper on the Mersey Tunnel Railway, by Mr. F. Fox, read at the Institution of Civil Engineers, we referred to the ventilating machinery, but we omitted to mention that this machinery was made by Messrs. Walker Brothers, of Wigan, and that special reference was made at the meeting to the excellent working of the fans.

One of the largest photographic views ever exhibited is to be seen in the New South Wales Court at the Indian and Colonial Exhibition. It is 20ft. in length, and furnishes a complete panoramic representation of the city of Sydney, Port Jackson, and the suburbs. It was taken from the cupola of the Garden Palace, subsequently destroyed by fire, and is a magnificent specimen of photographic skill.

Messrs. Buckley and Taylor, engineers, Oldham, have during the past fourteen days started two pairs and one single engine, all of the horizontal compound tandem type; one pair for the Leesbrook Spinning Company, Lees, near Oldham, capable of driving 1200 indicated horse-power; one pair for Messrs. Jno. Smith and Son, Holyrood Mill, Oldham, capable of driving 1000 indicated horse-power; and one single engine for the Crown Spinning Company, Oldham, capable of driving 600 indicated horse-power. These engines are well proportioned, simple in construction, and highly finished, and are in every respect equal to the best productions of these well-known makers.

A machine for shearing sheep is said to be in successful operation in Victoria. It is made of brass, in the shape of a small trowel. The motion is actuated by a small turbine wheel, about 3in. in diameter, geared into another wheel, on which is fixed a cutter. In front is a comb, serving as a guard against cutting the skin. The steam is conveyed from the boiler by an india-rubber tube, which is double, having one inside the other. The inner one is the injection, and the space between the two the ejection. The machine is used in the same fashion as the shears, but cuts, it is stated, much quicker and far cleaner, without the least danger of injuring the fleece or sheep.

The Bath and West of England Society's Show opens next Wednesday. Arrangements for the show at Durdham-down, Bristol, are almost complete. The entire area of the showyard exceeds 40 acres. There will be a good show of implements, the entries numbering 320, against 208 at Brighton last year. Machinery in motion will occupy a large space; last year at Brighton there were only fifty entries, and this year there are eighty-two. It is said that there will probably be at this show the largest exhibition of this class of machinery in motion ever held in this country. From a comparative statement of entries, it appears that there are of machinery in motion eighty-eight compartments; seeds, 441ft. run; agricultural implements, 4499ft. run; cattle foods, artificial manures, &c., 740ft. run; miscellaneous articles, 1470ft.; open space for hay barns, greenhouses, &c., 2118 square yards. The show closes on Monday, the 7th of June.

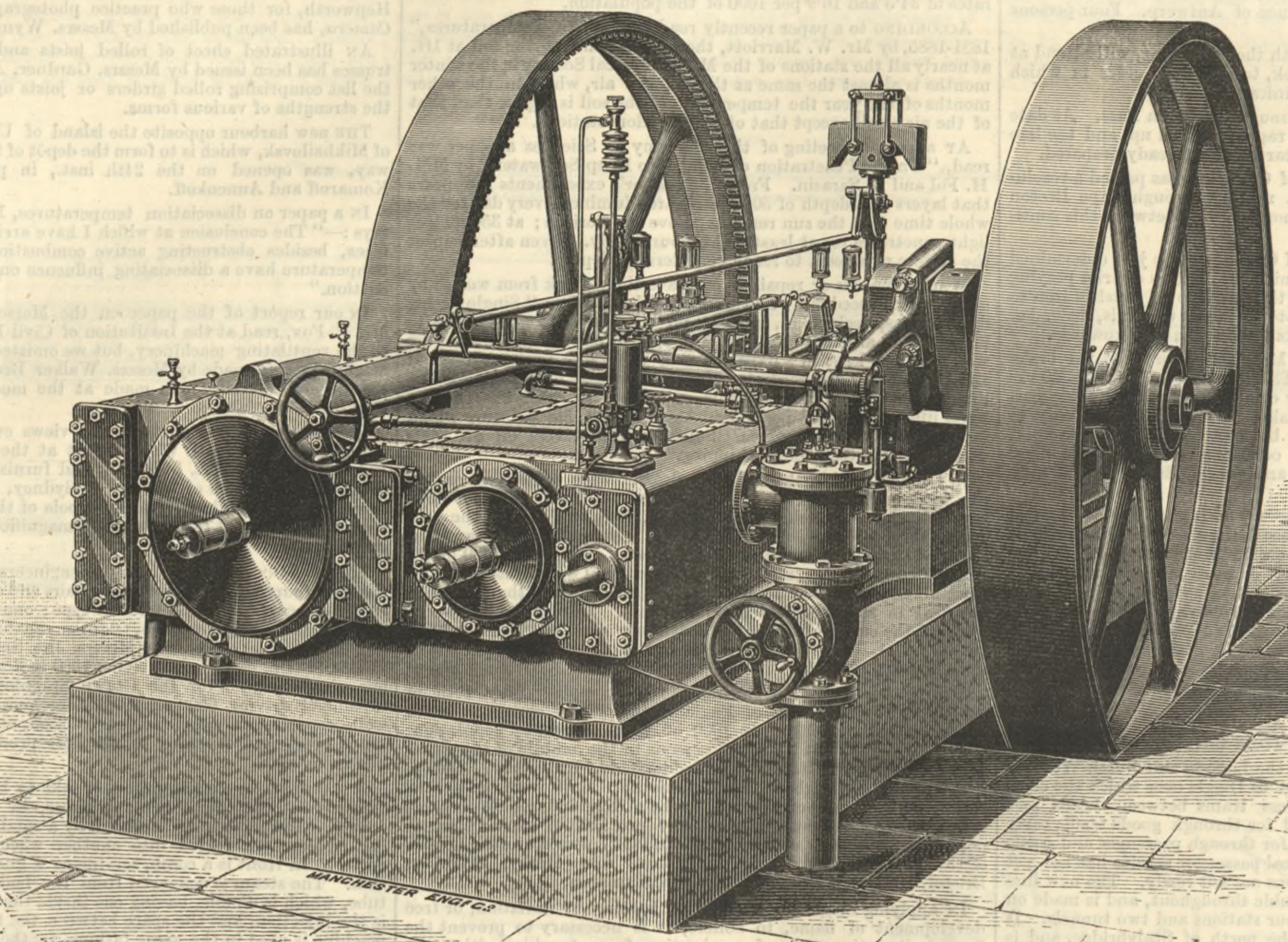
One of the leading men in Sunderland, Mr. James Hartley. J.P., died at the Langham Hotel, London, on the 24th inst., after a short illness. Mr. Hartley was born in 1810, and when a young man he acted as manager for Messrs. Chance, glassmakers, Birmingham. While there he experimented, and discovered a system of manufacturing rough plate glass, which he patented, and, in conjunction with his brother, commenced in 1833 the Wear Glass Works at Sunderland, which have attained a world-wide celebrity. Mr. Hartley also discovered a method of making coloured glass, which is now largely used for church windows, &c. The works occupy a very large tract of land, and have for many years afforded employment to large numbers of men and boys. In 1865 Mr. Hartley was returned to Parliament for Sunderland as a Conservative, and sat until the dissolution of 1868, when he retired. He was a Deputy-Lieutenant of Durham, a county magistrate for about forty years, and a borough magistrate for forty-six years, and was an alderman and twice mayor of the borough. He was also connected with other public bodies in Sunderland, and a director of the North-Eastern Railway Company.

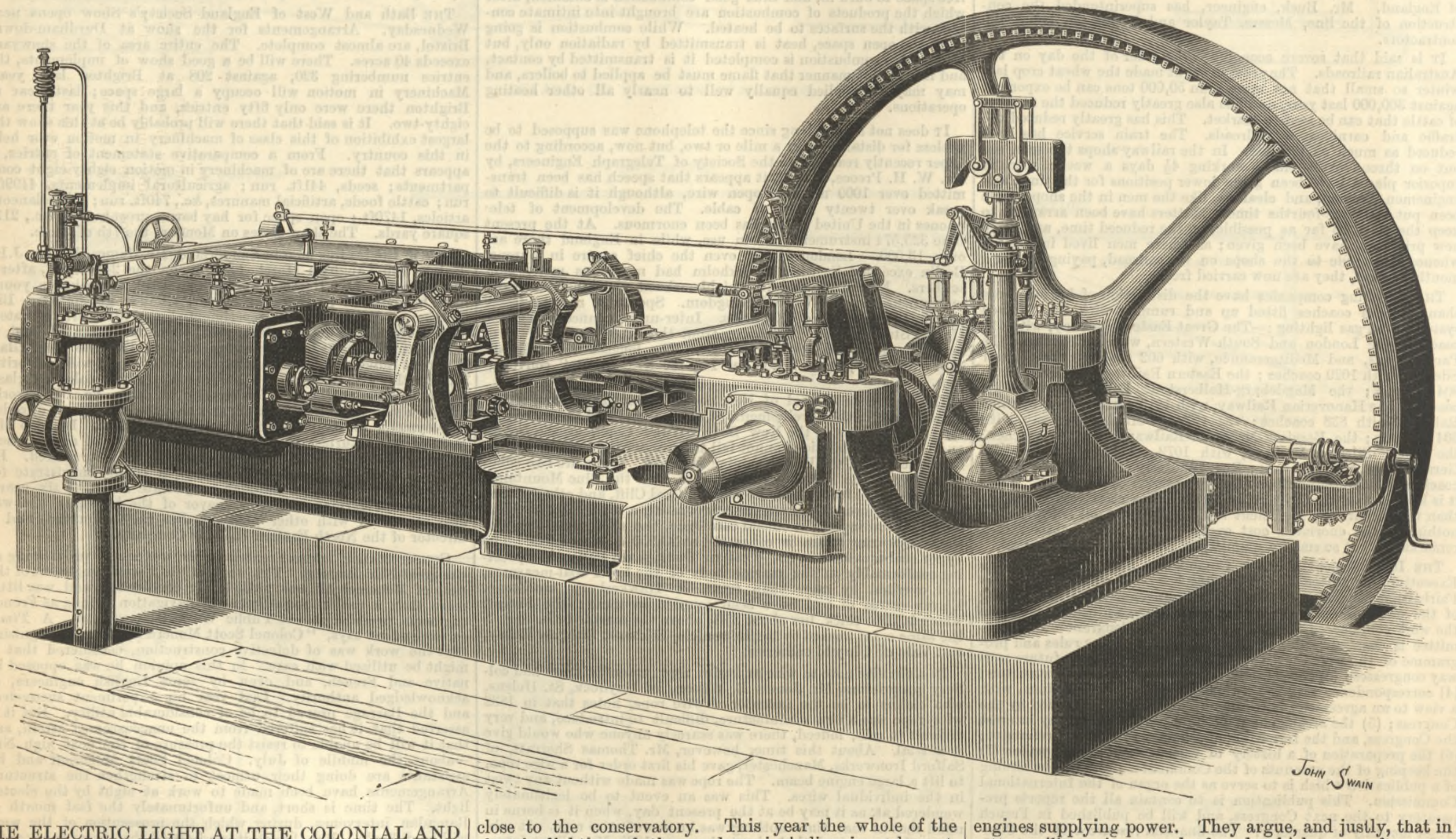
Considerable interest centres in the works now progressing at the great Nile Barrage. This work of the French engineers of the time of Mehemet Ali was until lately condemned, and was little more than a useless impediment to navigation so long as French engineers presided in the Public Works Department. A *Times* correspondent says, "Colonel Scott Moncrieff, though recognising that the work was of defective construction, considered that it might be utilised with care. In this opinion he was opposed by native and French, and even by some English engineers, of acknowledged authority. Last year his experiment succeeded, and the Barrage proved to be of considerable utility. But it is asserted that it has suffered from the unaccustomed strain, and that it will be unable to resist the pressure of the next high Nile —about the middle of July. Colonel Scott Moncrieff and his assistants are doing their utmost to strengthen the structure. Arrangements have been made to work at night by the electric light. The time is short, and unfortunately the fast month of Ramadan intervenes, during which the prosecution of the work will be difficult. But though it is admitted that there is cause for some anxiety, the Colonel yet hopes to prove that the work of his French predecessor can be made to fulfil the object for which it was constructed at enormous cost. With its usual generosity, the local French press vilifies the Colonel for endangering the architectural beauties of their countryman's design."

On Tuesday, the 18th inst., an interesting and important stage in the course of the execution of the improvements being carried out in the Butterley Company's Codnor Park Works was attained in a trial start of the new sheet mill. This mill is believed to be one of the finest yet put down in the kingdom; and, indeed, it has been said that this mill is at present the largest in Europe. It is driven by a high-pressure horizontal engine made at the Butterley Works, with cylinder 30in. diameter and 5ft. stroke, having double slide valves to cut off at any desired proportion of the stroke. The mill has two pairs of chilled rolls 25in. and 26in. diameter, and is intended for the rolling of iron and steel sheets from $\frac{1}{8}$in. thick down to almost any thinness that can be required. It has been constructed at the Codnor Park Works. The engine was started by Mrs. Fitz-Herbert Wright in the presence of several of the proprietors and the managers of the works, and the start was accomplished without a hitch of any description, the ponderous fly-wheel of nearly 70 tons looking really majestic in evidence of irresistible power. The Butterley Company will now proceed forthwith in the erection of two new three-high merchant mills, on the completion of which the Codnor Park Works will be second to none in the kingdom in the excellence of machinery for every branch of the manufacture of iron and steel.

COMPOUND ELECTRIC LIGHT ENGINE.

MESSRS. GALLOWAY AND SONS, MANCHESTER, ENGINEERS.





THE ELECTRIC LIGHT AT THE COLONIAL AND INDIAN EXHIBITION.

No. I.

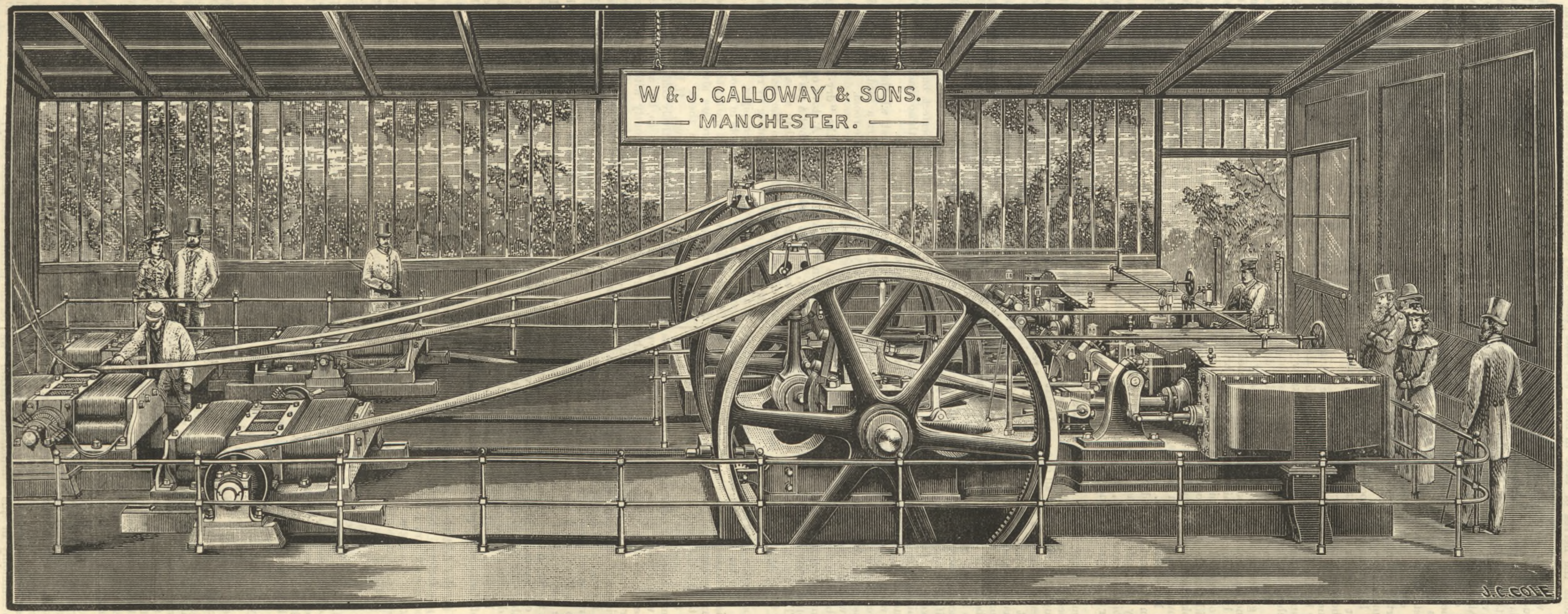
LAST year we published an elaborate series of articles on the electric light as displayed at the Inventions Exhibition. These articles dealt not only with the practice of electric lighting, but with its theory as well. They covered a very wide range, and were so complete and exhaustive as to render it quite unnecessary for us, in dealing with the lighting of the Colonial and Indian Exhibition, to do more than describe in somewhat general terms what has been done. Broadly speaking, the whole of the lighting may be classed under two heads, namely, (1) the lighting of the gardens, and (2) the lighting of the buildings. It is with the first we propose to deal this week. Concerning the second we shall speak at another time.

The lighting of the gardens may be divided under three heads—(1) incandescent decorative lighting; (2) arc lighting; (3) the illumination of the fountains. Last year the gardens were lighted by Messrs. Siemens, power being supplied by three Goodfellow and Matthew's engines, driving Siemens' dynamos direct. Steam was obtained from a three-furnace Babcock and Wilcox water-tube boiler, the plant being placed in the west corridor close to the conservatory. This year the whole of the electric lighting of the gardens, including incandescent, arc, and fountain lighting, is being carried out by Messrs. W. and J. Galloway and Sons, Knott Mills Ironworks, Manchester. Hitherto this firm has been best known as makers of boilers and engines. In taking up electric lighting Messrs. Galloway have broken entirely new ground, and the circumstance testifies to that remarkable flexibility which distinguishes some English engineering firms, and which places them in a position of considerable advantage over those who, getting into a groove, continue to run in it year after year, and are thus entirely dependent on one or two branches of trade. Messrs. Galloway hold certain views concerning electric lighting which appear to us to be so sound that we do not hesitate to place them before our readers. They are no doubt based on careful observation of the results which have hitherto been obtained by various engineers and firms who have made electric lighting their business both at home and abroad.

Messrs. Galloway hold, then, that the first essential to successful electric lighting is that a steady and sufficient current shall be available. They believe that much of the failure and disappointment that have been experienced hitherto has been due to the irregular nature of the current supplied, and that this irregularity can be traced to defects in the engines supplying power. They argue, and justly, that in cotton mills engines can be found which year after year run with perfect steadiness for nine or ten hours a day; that these engines do not get hot bearings or break down, or give any trouble of any kind. Certain principles of construction guide engineers making such engines, and these principles, modified with judgment to suit new conditions, being observed, it is possible to produce engines for electric lighting purposes which shall give results quite as good as those used in cotton mills. Messrs. Galloway have designed an entirely new type of compound engine for electric lighting; and three of these engines are in use at the Indian and Colonial Exhibition—two in a special shed near the end of what was last year the music gallery, and one in the corridor close to the Goodfellow and Matthew engines, which, with the dynamos and the Babcock and Wilcox boilers, have become the property of Messrs. Galloway. On page 413 will be found a general view of the Galloway electric light shed, and above we give an end and side view of one of their engines.

The engines are of the Woolf type, that is to say, the cranks are placed opposite one another, or at an angle of 180 deg., so that the steam exhausts directly out of the high-pressure cylinder, 15in. in diameter, into the low-pressure cylinder, 26in. diameter, the stroke being 2ft. 6in.

THE GARDEN ELECTRIC LIGHT SHED, COLONIAL AND INDIAN EXHIBITION.



The engines are, consequently, perfectly balanced both for reciprocating and rotary weights. The cranks are slotted out of the solid, and the shaft is $8\frac{1}{2}$in. in diameter, in order that great stiffness may be secured. The bed plate is cast in one piece, and there are two overhung fly-wheels, one on each side, 10ft. in diameter and 16in. wide on the face, so that the engine is perfectly symmetrical. The crank shaft is probably the heaviest that has been used for an engine of the given dimensions, making 100 revolutions per minute with a steam pressure of 75 lb. The crank shaft brasses are in four pieces, adjustable with wedges and screws. They were very carefully fitted in the plummer blocks, jammed tight and bored out in place at one operation, and then parted by a special tool. We are not ourselves much in favour of four brasses, principally because they are only a good job when perfectly fitted; but Messrs. Galloway have disarmed criticism in this respect. The slide valves are flat plates about $1\frac{1}{4}$in. thick, six in number—that is to say, two admission valves for the high-pressure cylinder, two intermediate valves, which are at the same time exhaust valves for the high and admission valves for the low-pressure cylinder, and two exhaust valves for the low-pressure cylinder. The exhaust steam is conveyed under the floor to a cast iron box, 4ft. square, where it parts with much of its water, and thence passes up the brick chimney of the three Galloway boilers which supply steam. These, with a fourth or spare boiler, are the same boilers that were in use last year.

The valves are driven by two excentrics. One of these is of cast iron for the low-pressure slides; the other is of wrought iron turned out of the solid in the centre of the shaft, and it drives a rocking expansion link of the kind regularly used by Messrs. Galloway, and the high-pressure admission slides. The expansion gear is not automatic. We have had occasion before now to say that we hold automatic expansion to be unnecessary, when the load on the engine is very uniform, as it is when driving a proper installation, and we are pleased to see that Messrs. Galloway hold the same views. The grade of expansion can be regulated in a moment with the greatest nicety by hand, by means of the wheel seen at the back of the engine, which works a screw traversing the die in the expansion block. The governor is of Messrs. Galloway's well-known parabolic type. It is driven by grooved friction wheels and mitre gear, and operates a double-beat throttle valve in the vertical branch of the steam pipe. A coiled spring is so arranged round the weigh shaft that its tension can be altered at pleasure, which has the same effect as increasing or diminishing the dead weight on the governor; and in this way the speed of the engine may be varied within wide limits without trouble, which is not always the case when the action of the expansion gear controlled by the governor is automatic. Thus, for example, it was intended to run the engines at ninety revolutions, but as rather more work was required from the dynamos than was anticipated, the engines have been speeded up to 100 revolutions. We have no reason to doubt that they might be run up to 200 revolutions with perfect safety.

The lubricating arrangements have been specially devised to overcome all difficulties. The crank-shaft has holes bored down each end, then along the outer crank web and then through the crank-pin; openings are made from this latter hole to the surface of the pin. The outer ends of the holes in the crank web are subsequently stopped by screws. Thus, passages exist from the ends of the crank shaft to the crank-pins. A sight-feed lubricator is fitted to each end of the crank-shaft, and the centrifugal force is found much more than sufficient to draw in the oil and so lubricate the big ends in the most perfect manner. Sight-feed lubricators are fitted to every bearing, even to the cast iron excentric, which has a long groove or cell cut in the top of the hoop, into which the oil drops, no matter at what part of its throw it may be. The engine is very nicely finished with Russian iron. All the parts are of unusual finish, resembling, indeed, the very finest locomotive work. We believe that these are the best engines Messrs. Galloway have ever constructed. This is saying a good deal, but not more than they deserve. For ourselves, we can say that we have neither seen better designs nor better workmanship. The fly-wheels are fitted with cogged rings, and a very simple barring gear. A small cogged pinion is mounted on a shaft with a quick pitch screw feather; when the axis of the pinion is caused to revolve by a winch handle, the pinion is screwed along its spindle by the action of the feather into gear with the fly-wheel cogs, and the engine can then be turned by hand, but as soon as the engine begins to revolve under steam, the pinion is automatically screwed back out of gear. The gear is combined, when used for larger engines, with a little steam engine, but hand gear suffices at the Colonial and Indian Exhibition.

The engines illustrated above drive each two Elwell-Parker dynamos, compound shunt wound, each giving 250 ampères and 220 volts at 560 revolutions. The dynamos are driven direct, as they should be, without a counter shaft, by which loss by friction is avoided and money saved. The countershaft is, of course, sometimes unavoidable, but it is worth going to some trouble to get rid of it. These four dynamos are employed exclusively on incandescent lamps, of which there are 11,500 of 5-candle power worked with a 25-volt current. The whole of the wiring—in one word the whole of the electric work—has been carried out by Messrs. Galloway, Mr. Bates having charge of the electric work. The third engine in the corridor drives one "F 3 Victoria" Brush machine, 220 ampères and 220 volts, and one 20-light Brush machine of an older pattern. The Victoria machine supplies current to 16 arcs used for the fountains. The other machine feeds 20 arc lights in the grounds, and we may direct attention to two wrought iron lattice masts 80ft. high, made by Messrs. Galloway, to carry rings of Brush arc lamps. For smaller installations Messrs. Galloway have brought out a very nice compound engine, with cylinders 5in. by 8in. by 10in. This at 200 revolutions indicates 14-horse power. It has only one slide valve for the two cylinders. It is employed at the Exhibition in driving twenty incandescent lights in the engine shed.

Messrs. Galloway have completely remodelled the fountains and the system of illumination according to the wishes of Sir Francis Bolton. Hitherto electric lights were placed in the clock tower in the grounds to produce certain effects, in addition to the lights underneath. These have been done away with, and the fountains are illuminated entirely from below. For this purpose eight ordinary hand arc lamps of 8000-candles nominal each, and seven holophotes are used. The first illuminate the outer jets, the last the central jets. The first consist each of a box in which is fitted on the bottom a concave mirror, over which are two carbons arranged horizontally and adjustable by hand, similar to search lights in fact. The holophote lamps are the same in all respects, but over each is laid a built-up lens of prisms like those used in lighthouses, so that a powerful parallel beam of light is thrown upwards on the leaping water. Great slides of coloured glass are fitted over each lamp, and thick glass plates, water-tight, prevent water getting in the lamp-room under the fountains. A novel effect is produced this year. A 3in. steam pipe, supplied from the Babcock and Wilcox boilers before mentioned, runs round the fountains, and by means of jets great rolling clouds of steam can be caused to mingle their effects with those of the spray.

In the clock tower is a small chamber, the windows in which face the fountain. Standing on a table in front of one of the windows is a set of five key boards, like those of an organ on a small scale. These communicate with signals in the lamp room under the fountains, and here Sir Francis Bolton takes his stand every night, and for half-an-hour, by playing on these keys, so to speak, produces the admirable effects which delight and surprise thousands of spectators. No fewer than nineteen men are employed every night under the fountain. About 1000 gallons of water are used per minute, under a pressure equivalent to a head of 160ft. Under Sir Francis Bolton's room is the switch room. Of its arrangements it would be impossible to give an intelligible idea without drawings.

Beyond any question this is the most remarkable electric light installation in the world, and the arrangements from beginning to end reflect the greatest credit on all concerned.

FUEL AND SMOKE.*

LECTURE I.

I MAKE no apology for bringing before a Royal Institution audience a subject having more connection with the improvement of the conditions of daily life than with abstract science. As a rule, it is no doubt best for a devotee of pure science to adhere to his chosen pursuit, and to speak of that which he best knows; but two things determined me to abandon this course when honoured with a request from your secretary to lecture in this place. First, the strong desire which has long possessed me to do something towards helping forward the movement against the physical evils, the paltry and unnecessary evils, under which we dwellers in cities too patiently suffer; and secondly, the remembrance of the spirit and object with which this august Institution was founded, and especially of the labours of Count Rumford in the precise direction towards which my own thoughts had been for some time tending.

The pollution of the atmosphere existing in Count Rumford's day, though it very properly excited his disgust and apprehension for the future, must indeed have been trivial to what it is now. Had he been effectively listened to, much of the present evil would not exist; but he was not, and the result is that the vast majority of dwellers in a city—those unable to leave their vocations and retire in the summer to the country—scarcely ever breathe the pure air of heaven or behold the unveiled face of the sun. They eke out their pallid existence in slums and courts into which the sun scarcely ever penetrates and no fresh breath ever blows. There among sweltering filth they live—they die; and so long as they remain sufficiently quiet and uncomplaining we are content to have it so.

But perhaps we are not content; perhaps we only acquiesce because we do not clearly see a remedy. It is in the hope, rather than in the belief, that this attitude of mind is largely prevalent that I have determined to urge the consideration of the subject in every way that I can and upon every convenient opportunity. Not indeed that I am able to point out a thorough, complete, and instantaneous remedy, immediately practicable; but I do feel able to indicate the main lines on which gradual, I hope rapid, improvement is possible. And that is what I shall try to do.

First, I wish to direct your attention to what is usually called the "combustion" of coal. There are certain bodies which when you heat them *melt* before they begin to do anything else; such bodies are ice, butter, lead, and iron. There are certain bodies which take fire and *burn* when you heat them, before they do anything else; such bodies are hydrogen, phosphorus, and gunpowder. There are certain bodies which chemically *decompose* when heated, before they are able to do anything else; such bodies are marble, feathers, wood, and coal. Bodies in this last category cannot properly be said themselves to burn. Their products of decomposition may or may not be combustible, and if combustible they may or may not burn. The products of decomposition of marble are two—one solid, one gaseous (quicklime and carbonic acid), and both are absolutely incombustible. The products of decomposition of coal, though far more complex, are likewise roughly separable into two classes, the solid and the gaseous; and both are thoroughly combustible under favourable conditions, neglecting the ash for the present. It is easy to distil coal, however, without allowing either its solid or its gaseous constituent to burn; it is done every day with full knowledge and design at a gas works. It is likewise done every day, not in knowledge but in ghastly ignorance, on our so-called coal fires.

Consider for a few minutes the structure of a coal fire; you will see that it has three main stages: still, gas fire, coke fire. You empty on a shovelful of coal. Very good; this has first to be heated and decomposed, separated into its gaseous and solid constituents in fact, and the gaseous ones distilled off. While they are being distilled they *may* catch fire and burn; but they commonly do not take fire for some time, because they are scarcely hot enough to begin with. And even if hot enough, they are so mixed with carbonic acid from the smouldering mass below that they cannot properly burn. Where is then your fire? It is not a fire at all; it is a still: a sort of crude gasworks. It warms nobody. So far from that, evaporation consumes a good deal of heat, and the fire itself below is like to be put out unless it be pretty vigorous. The coal gas is just evaporating or distilling up the chimney; you can sometimes start it burning by simply applying a match to the ascending stream of gas, but more frequently the carbonic acid soon quenches an incipient flicker, and the poker has to be brought into requisition to increase the supply of air.

(The effect of feeding a flame with carbonic acid was illustrated by lighting a spill at the chimney of a paraffine lamp; also by supplying an ordinary gas jet with burnt air by holding it over a tin plate chimney with a large "solid flame" burner below it. The flickering smoky appearance of ordinary fire flames is at once precisely imitated, and the cause of their flickering is perceived. It is easy to put a fire nearly out by burning newspaper under its bottom bars; whereas burning a bit of paper on the top of a dull fire helps it, sometimes to a surprising degree.)

But is it pure gas which is thus ascending? Good heavens! look at it; smell it. You have not far to go. The only difficulty in smelling it is that we get so accustomed to it; our lungs are full of it every winter day of our lives. I believe that if you could suddenly transport a Highlander off his native heath into such a city as, say, Manchester, on a dull day, without the gradual initiation of the train or the suburbs, he would feel nearly suffocated. How often can one open one's mouth and lungs, and inhale invigorating breezes, in a city? We can sometimes almost do so with a strong west wind; but, ordinarily, people parade the streets with their mouth grimly shut, filtering the air steadily through their nostrils.

The products of a gasworks are not gas and coke alone; they include ammonium salts in large quantities, sulphur also, and tar, in which are latent a multitude of useful aniline dyes and other coal tar products, creosote, naphthalene, and asphalt. The number of compounds now obtainable from coal tar is quite astonishing; not only colour materials, but some medicines also, and quite recently Dr. Fahlberg has extracted a substance with the pleasing name, "benzyl-sulphonic-imide," which is able powerfully to excite the nerves of taste in much the same manner as sugar, but some 200 times more powerfully. This substance, about which Sir Henry Roscoe will doubtless next week tell you much more, it is proposed to call "saccharine;" and Sir Lyon Playfair hopes it may replace sugar in the diet of gouty old gentlemen and diabetic patients. I hope that it may thus subserve beneficent ends, but, with the inscrutable customs of trade at present in vogue, it seems just as likely to lend itself to purposes of adulteration, and to confer sweetness upon sand, or some other cheap, and let us hope innoccuous, material. (Some specimens of coal tar products were here exhibited.) The stuff we distil from our incipient fire contains portions of all these; it contains the potentialities of great industries and of fertilising manures—the gasworks is now the main source of ammonia required by plants—and what becomes of it all? Some little is happily deposited in the chimney; the rest hovers about in the air—a veritable plague cloud, the sign of the neighbourhood of a multitude of civilised men.

Walking in some unknown part of the country in the autumn, gathering, it may be, the blackberries as you go, you find them getting thinner and thinner on the bushes, and you know you must be approaching a village, whose children have been happy here before you. Travelling in some countries abroad, a deep-toned bell or a glistening spire announces the proximity of a town. In England its neighbourhood is otherwise heralded to you. You have been riding in a train, perhaps, through bright sunshine, when you gradually recognise that the sky looks more gloomy than it did, that the grass does not so happily flourish, that the trees look stunted and miserable; you conjecture you must be near a town. Yes, the gloom deepens, the air feels chill; you can now no longer see the sun. It must be a city! You are soon landed in the heart of it, and you realise that the gloom which perpetually enshrouds the place is the cloud of incense which the inhabitants have raised, either to beautify their common home, or as the symbol of the worship of their common god.

The smoke from factories, indeed, is more appalling than the smoke from houses, but I must confine myself to house smoke this evening, though it is essentially all one; and what I say of house fires applies in great part to factory fires, and *vice versa*. Think now what becomes of the smoke. Its larger particles settle gradually as smuts, some fine specimens reaching $\frac{1}{2}$in. in length, but the majority are small blacks which crowd the air, which dirty our books, our clothes, and our furniture, and keep one or two maids in each moderate-sized house busy in moving it about from place to place. I suppose an energetic housemaid would be happy if she could manage to prevent dust from ever settling—could keep it permanently suspended in the air. Plenty is in the air as it is—we cannot move in a room without knocking out clouds of it, which are visible enough in a bright light, and which when so seen excite inevitable disgust. But not seeing, we breathe this filth and call it air; our lungs are marvellously constructed, or they would be absolutely clogged, matted together with the reeking abomination we pass through them. We live, but that we live thus healthily and pleasantly is not true. Plants experience the evil no more than we do, but they have less rapid power of adapting themselves to outward circumstances. They must have clean and open-pored leaves—lungs that is—or they flag and fade. They must have sunlight, or they die.

It is only 200 odd years since apple trees grew and bore fruit in the Barbican. How far are we from such a state of things now? Yet there is no necessity against it. The neighbourhood of human beings is rather beneficial to vegetation than otherwise; that which slays them is the tarry and sulphurous compounds in the smoke. The tarry products of coal smoke are abundantly evident in the atmosphere; our buildings, our statues, our hands are coated over with a black grease, and washing four or five times a day scarcely keeps them pleasantly clean. And then the sulphur—sulphur burns to SO_2, and this soon oxidises and dissolves to sulphuric acid—oil of vitriol. I do not care much for statistics, but it is easy to reckon how many hundred tons of sulphuric acid are turned loose into the London air per day. You have only to find out how much coal is burnt in a day, and then the average percentage of sulphur in coal—2 per cent.—will give you the result; 6 tons of sulphuric acid are produced per 100 tons of coal burnt. Think you that oil of vitrol is wholesome breathing for plants and animals? It must corrode and gradually undermine the strongest constitution. It attacks books, pictures, buildings, most visibly; it is dissolving the present Houses of Parliament—perhaps the one good thing it is capable of.

Well, so much for the first stage of our coal fire, when it is really a still or gas factory. Now for the second or flaming stage. The gas coming off now is of a more easily combustible nature, and being also of a higher temperature it burns, and so far as it completely burns it constitutes a gas fire. Now many people abuse a professed gas fire, thinking it gives a dry unpleasant kind of heat and an evil smell. I admit that it is possible for a gas fire or any other fire to smell if it be ill-lighted or ill-constructed, or if it burns badly, but I deny that a professed gas fire smells any worse than a gas fire which pretends to be something else. If your gas fire smells, something or somebody has to be abused—of that there is no doubt. Sometimes it is the person that lights it. Before lighting any fire a match should be held in the chimney opening to see that the draught is up the chimney and not down. If you light the fire with a down draught in the chimney no gas fire can help smelling, and no coal fire can help "smoking." No fire ought to be expected to start its own chimney draught. An up-draught must either exist beforehand or it must be made. If the chimney is in regular use, and if it be built with thick enough walls, its bricks usually keep warm enough to maintain a steady up-draught through the night, especially as the night chilling of the outer air helps to maintain the necessary difference of temperature; but if the room be only occasionally used, as is often the case with a gas fire, and other stoves in the house are at work, you will generally find a stream of air being sucked down the chimney—an air supply, in fact, for the house. The room is thus ventilated—especially if it is an upper room with a short chimney—much as if its window was open. It is for a bedroom unconscionably cold, and its air has a sooty flavour. We are desperately careless how we get air for our houses. We admit *light* with some care and lavishness, if indeed we have any voice in the matter, as commonly in this "dishonoured nation" we have not; but we let the *air* leak in as best it can, down chimneys, through coal cellar grids, up drain pipes, and—till quite lately—often through sewers. The cut-off system of drainage prevents this last now, and sink traps are intended to prevent scullery pipes from officiating as air shafts. But even without them, if you examine how air is admitted to your house you will not be pleased. Through the coal-cellar grid, near the ash-pit, you will probably find it in a plentiful and constant stream. You may also find it coming in through grids intended to ventilate the spaces between the floors when the bell-hanger disports himself. You seldom find a professed and satisfactory air shaft, arranged so as to supply the whole house with deliberately chosen air; most convenient is such a shaft to warm in winter and to cool in summer.

What we want about a house, and everywhere else, is for each thing to have a definite function and to preserve it. You want a coal cellar to be a coal cellar, and a drain to be a drain, and not to act as amateur air shafts as well. You do not particularly relish your bedroom being ventilated through a chimney; though indeed, you might do worse than that. You want a window to admit light, and not draughts as well; and doors to admit people, and not bronchitis. Similarly I prefer a gas fire that professes to be a gas fire, and not one that shams that it is something else.

Well then, before you light any fire you should turn the draught in the chimney if it be wrong way by burning a bit of newspaper in it; quite a small bit usually suffices. There is no possible fear of setting the chimney on fire if you use a real gas fire, because there is no soot. But suppose you have lighted the fire properly and it even then smells, the next thing to consider is whether there is a sufficient air supply to the room, because if the room is nearly air-tight a gas fire will smell and a coal fire will technically "smoke." Into most rooms the air leaks through chinks, through the keyhole, and under the door, keeping one's feet delightfully cool; nevertheless, it is better so than to have no air at all, though a branch from a main air shaft would be best. Supposing, however, that the air supply is sufficient, and the gas fire still smells, then abuse the fire; but do not abuse gas fires as a class, abuse that particular specimen, or at most that and its congeners, and hunt about for some better kind. The old arrangement of clinkers and fire-clay held together by asbestos packed into an ordinary grate is, I suppose, still the most prevalent form. It is not a good form, it consumes a lot of gas in proportion to the heat; it takes some time to heat up, and it is apt to smell. It is extravagant because of the solid or deep arrangement of it. An open fire can only warm a room by radiation, and to this end all hot surfaces should have an unobstructed view of the room. Combustible hot clinkers at the back do indeed help to maintain a fire, but they cannot emit heat directly. In the case of a gas fire, the clinkers are not combustible, the amount of burning material is strictly regulated by the gas tap, and all hot surfaces behind others are useless, except to warm the chimney. By arranging clinkers as a wall, by playing the flame up their face, and by stopping as far as possible all unnecessary air draught, these asbestos fire-clay fires can be improved. Or you may have a vertical slab of fire-clay, with filaments of asbestos protruding from it into a flame sheet, whose function is to heat them white hot instantly, so as to give a good radiating surface. I do not suppose that gas fires are yet perfect, but the best kind I know at present in the market are those made by Mr. Fletcher, of Warrington, on these principles.

Here are specimens. The test whether anything comes out of a fire into the room is to burn a bird-tail feather in the fire and see if you can smell it in the room. Some of Mr. Fletcher's fires will stand this test.

People further complain of the "dry-heat" of a gas fire. I do not know what they mean. A stove, or anything which heats the air, dries it undoubtedly, but a gas fire working by radiant heat can dry the air no more than a coal fire does. It may be convenient here that I explain the main differences between heating by convection and heating by radiation. Any convection method, stoves, hot water pipes, hot air, &c., proceeds upon the plan of warming objects in a room by means of the air. The air is first warmed, and it warms them. Accordingly, on this system, walls and furniture are always liable to be cooler than the air in contact with them. Now there are certain objections to this state of things. If the air be damp, dew is apt to be deposited on comparatively cold surfaces and to trickle down detrimentally. Not only so, but as Mr. Clark and I have recently discovered, simultaneously with Mr. Aitken of Edinburgh, dust is bombarded out of warm air on to cooler surfaces in contact with it. It is for this reason that ceilings get black over gas lamps, that walls get dirty above hot-water pipes, that soot is deposited in chimneys, and lamp-black on porcelain. If a flame smokes, extra solid matter is provided by it; but there is usually plenty in town air to make a black patch on a ceiling above a clear flame, or even above an incandescent electric lamp fixed near enough to it. All suspended solid matter is driven out of air on to cold surfaces. On the other hand, surfaces warmer than the air drive the dust away and keep themselves almost free. A large flat horizontal surface may indeed receive a deposit of dust, even though slightly warm, but it protects itself a good deal, especially from the smaller particles. A vertical or inclined surface may protect itself almost completely. (A new experiment was here shown, of two black conical flasks, one full of hot water, the other of cold, both covered by a bell jar full of thick white smoke. After some ten minutes the cold one was found thickly covered, as with hoar-frost, while the hot one remained black.) A radiation system of heating, *i.e.*, open fire or sun-light, brings about the opposite conditions. The air is warmed only by means of solid objects; they are first warmed and communicate heat to the air which passes over them. Accordingly on this system no such effects as we have just described are produced, and things get much less dusty. The only objection to this system is that to do the whole of one's heating in cold weather by pure radiation is unnecessarily extravagant, and leads to a closing of apertures and deficient ventilation for fear of draughts, because, the warming of the air being a slow and indirect process, when once hot it is desired to keep it and not let in fresh. This is decidedly objectionable, and the best plan of warming a house is no doubt a combination method, both radiation and convection. The air supply should be ample, but it should have the chill taken off as it is introduced. The walls and floor should be heated by radiation, so as always to maintain them a degree or two above that of the air. By properly adjusted arrangements of this sort an exceedingly pleasant and uniform temperature can be attained; and the result is both healthy and economical. Some stoves intended to aid in the accomplishment of this method I shall shortly direct your attention to. I have not spoken of the cheap and nasty gas fire without flue—no escape for products of combustion. I would not bring such abominations near the place.

A coal fire in the flaming stage is thus essentially a gas fire, but it is a very bad gas fire. The gas is, so to speak, made on the premises and made badly; it is absolutely unpurified of course, and it is so mixed with carbonic acid that it only burns in a flickering, undecided, smoky way. Flames interesting to watch! Yes, in a camp fire in the back woods, or in a fine old isolated country house, they are very harmonious and picturesque. But in a town! well, if people are so enamoured of the appearance of coal fire flames that they are content to defile and render invisible everything else, all we can do is to stop them by

* Two lectures in the Royal Institution, London, by Prof. Oliver Lodge, Saturday afternoons, April 10th and 17th, 1886.

law from polluting the common air for their own amusement, just as one can already stop in some measure the pollution of rivers.

I shall suppose it admitted that the home manufacture of gas is not everything that can be wished, and that it is better, on the whole, to have gas made properly at some central station, purified of its valuable but deleterious products, conveyed to the house silently and cleanly in pipes, and then burnt completely and smokelessly under perfect control; the fire being able to be lighted, raised, lowered, or extinguished precisely according to need. It is better to have such a fire as this than to have a sort of amateur gasworks on every hearth, the supply for which is carted about the streets, shot down with dust and noise into your cellar, carried thence by female labour to the various rooms. "Do just attend to the fire; it's going out." "The scuttle's empty." "Then ring the bell." What a roundabout way of keeping warm! And when fresh coals are put on, what is the result? Frequently a smoky still for some twenty minutes, over which you may sit shivering, not daring to poke it, until a welcome tongue of flame shoots out, and you know that the gas-burning stage has fairly begun.

But there is yet the third stage to be considered—the red-hot or glowing stage—when flames have ceased, and the carbon alone is quietly and smokelessly burning. Yes, this is the best and only perfect stage of a coal fire. But what is it really that is burning? It is not coal at all, it is coke. You have consumed or distilled away into the air the volatile products of the gas-making process, and naturally the coke remains; and if you thus like a coke fire, why not try one, or why not burn anthracite, which is almost a natural coke. There is a great deal to be said in favour of anthracite. They burn it largely in Canada, and their cities are accordingly a pleasant contrast to ours; but they don't know when they are well off—the manufacturing mania has seized them, and by Protection they deny themselves comforts in order that they may achieve manufactures. Accordingly they hanker after bituminous coal, and have erected a few tall chimneys now in Montreal, and when thick smoke successfully rolls out of them they rub their hands, and say, "Ah, ha! we are not yet quite a manufacturing nation, but we are beginning to look like one."

Curious mania this; very striking for the social philosopher of the future, this greed of people for markets. It is not that they want the goods themselves—no, they will keep them out of their country by taxation. It is not to supply ragged children with boots and clothing that they labour hard and deny themselves the breath of heaven and the light of day—for then it would be noble self-sacrifice. No, it is to ship to China, Africa, Burmah, anywhere; and if a shipload of their sold handiwork were sunk they would not lament, they would rejoice, and say, "Lo now we can make more." Remarkable human nature!

But undoubtedly anthracite or coke can be much more largely burned than it is; and it is a very fairly smokeless—not quite smokeless—fuel. What are the objections to it? It is difficult to light and to keep burning. You want special grates for it, and so on. Quite true. I admit all this, and I admit that no solid fuel can for an instant compare in comfort and convenience with gaseous fuel. Solid fuel needs carting to the house, carrying about the house, the fire needs attention at intervals, which attention is both noisy and dusty, and there are the ashes to be raked out, carried down, and carted away, and the ash of coke is considerable; and every morning, or indeed, without regular attention oftener, there is the somewhat serious trouble of lighting the fire.

Contrast all this with a gas fire. A housemaid brushes up the ironwork once a week when she cleans the room, and that is all the attention that need or can be given to it. You have an illness in the house; a coal fire has to be banked up so as to go on distilling half the night in a black and sulky condition, unfit even to boil a kettle; and yet, if you poke it, it flames and burns with such vehemence that it soon exhausts itself, and, moreover, makes the room too hot. If you have banked it up very scientifically it may last in this gloomy state till morning, but, if not, the nurse has to get up, and probably wake the patient with the rattle of fire irons. With a gas fire you light it once for all, and need never look at it again for a month; unless the room gets too warm, when you lower it, or too chilly, when you raise it. If you want hot water or toast it can be cooked immediately. No noise, no dust, no anxiety, and no attention. It is the perfection of a fire.

I said the red-hot stage of a coal fire was its best and only perfect stage; but how short a time is it allowed, or, indeed, able to last? You know by experience that, as soon as only glowing coke is left, it is time to start the gas-manufactory again. The heat required to distil fresh coal checks the ardour of a strong fire, and utterly damps a weak one. It must not go too low. You therefore have some more coal put on, and unless you do it yourself, or unless you are in blissful ignorance as to how it should be done, your nerves will be tormented with the bungling and stupidity exhibited in the process.

The method employed for stoking a fire is not the same in all parts of the kingdom; the orthodox London method is not the same as the Staffordshire method. There are two general cases depending on the state of the red-hot fire. It may have burnt into a red-hot hollow cave with a black top, or it may be more solid and red all through. The method commonly adopted in the former case is to beat down the hollow with a poker, and to put the new coal on the top; in the latter case, it is customary to rake the glowing mass a little forward and to put the fresh coal at the back. In Staffordshire the fire is stacked up in a more impressive manner. The fire being still in a sound and healthy red-hot condition, two scuttles are brought in, one full of lumps, the other of small coal or slack. The fire is drawn forward, a row of lumps is arranged on end all along the front, and then the other scuttle is emptied on the back, filling the grate up to the chimney opening with a nicely sloped pile of small coal, till it can hold no more and begins to dribble into the ashpan. Then with a brush the ashes are whisked about from the front bars a bit, and the whole is complete. In two hours that room is untenantable, except by a Staffordshire man or a salamander.

Now all this is wrong. The proper theoretical place for fresh coal is at the bottom of a fire, not at the top. The heat from above will then gradually distil it upwards, and the gas as it is given off, having to pass through a hotter mass above, may be almost completely burned. It is scarcely possible in a domestic grate to stoke it really at the bottom, though, indeed, grates on this plan have been attempted; so a compromise is necessary. The next best place to the bottom is the middle, and next to that is the front. If, therefore, you see your fire with a fine hollow in its heart be thankful, and stop the sacrilegious hand that would beat it down. Feed the fresh coal into this hollow, either through the bars, or, what often is more practicable, by gently raising a little the top crust. The coal will then take fire almost at once, and smoke will be reduced to a minimum. There will still be smoke—there must be smoke when crude coal is burnt just as it is dug out of the ground, as a savage might burn it; but it need not be excessive. Next time you feed the fire it will probably be solid, and you must then rake it back as much as you can and put the fresh coal in front; because, as the draught goes a good deal from front to back, putting it in the front is a fair imitation of putting it at the bottom. And if you want the coal to *burn* and not to *distil* up the chimney, you will never put a great quantity on at once. "Little and often" is the motto for all good stoking.

But this is troublesome. Yes, indeed, and I don't care how troublesome it is. The more bother the better. It is our one hope of curing the smoke evil as caused by domestic fires. You attack a manufacturer by means of his cash-box, sometimes his only vulnerable spot. You bully a householder by causing him trouble. When people get tormented about smoky chimneys they must do one of two things—they must either take the trouble to stoke properly, and so make a little smoke, or they must have some form of gas or coke fire, and so make none. I need not say which course of the two would be the better for the community.

But there is yet one objection—gas fires are expensive. Well at present they are. Yes, it will never do to attempt them; far better live in dim and smoke-laden air half our lives, getting away when we can for a whiff of something fresh and a glimpse of something green, far better to choke each other with the products of our hearth fires than have our gas bills doubled.

No, you say rightly, that's not fair. We cannot legislate for the rich alone. What are the poor to do if smoke is forbidden? Well, to this I may reply firstly that the very poor cannot, I fear, afford to make very much smoke even now; they have very little fire. Secondly, that the fire of the working classes is mainly a cooking fire, and that cooking by gas is even to-day actually and considerably cheaper than cooking by coal, besides being so much more cleanly. I would also say that for really cheap warmth an open fire is quite unsuitable; a stove is the cheap thing, and it may quite well be smokeless. An open fire is a luxury, by reason of its radiant heat and its ventilation; it is not, and never can be, cheap.

Do I then mean that the working classes are to be debarred from such a homely luxury as this? God forbid. They have few enough luxuries at present. I would far rather add to them rather than diminish them. But I cannot compare such a paltry difference as that between one form of fire and another, and the far higher and more ennobling luxury of being again able to breathe fresh air, to see a distant view, to feel the brightness of the sun; not once or twice a year on a laborious holiday, but at their very doors, and every day of their lives,

What then are we to seek for? We must have cheaper gas. The gas we now burn for illuminating purposes is far too expensive for universal warming; but cheaper substitutes are continually being invented. I hope next time to speak of the Dowson gas, the water gas, the Siemens gas producer, and others. Do not, however, think that gas at 3s. 6d. or 2s. 10d., or even 1s. 6d., a thousand feet is the ultimate thing that science can offer for domestic combustion. It is perceived now that the desideratum is cheap gas, and hundreds of inventors are turning their energies in this direction. Besides, regular coal gas can be vastly cheaper than it is now. The gas itself may be regarded as really a bye-product; it is the main pipes and purifiers that are costly, and most of the twenty-four hours these are, at present, almost idle. When gas comes to be used all day long for warming and cooking, instead of only a few hours in the evening for lighting, the same mains will serve for a much greater quantity of gas, and one may hope that its price can then be profitably reduced. Before next century begins I for one hope to see gas displaced altogether from its domestic lighting function, which it ill and unwholesomely performs, but employed, ten-fold more plentifully and a million-fold more beneficenty in replacing the barbarous, wasteful, dirty, and then, I hope, illegal, semi-combustion of solid fuel.

It is not products of combustion that we complain about. That which streams from our chimney is no product of combustion; it is a product of incombustion.

Factories are savage sinners in this respect, and them also I must tackle; but now I want to call your attention to some fireplaces which have been devised to mitigate or abate the smoke nuisance. I hope no one will be satisfied with smoke abatement. What I hope to see is smoke abolition; but meantime the contrivances for mitigating the evil are worth attention, and will serve to illustrate the principles I am trying to enforce. Understand that I bring these forward as illustrating one or other important points, not as being any one of them a perfect and heaven-sent contrivance. If one knew of such a piece of perfection, one's task of urging reform would be easy. But that is not the way things generally happen. Progress is commonly gradual, and we must try to go *viâ* less smoke to none at all.

(*To be continued.*)

ON CERTAIN DESCRIPTIONS OF INDIAN CASTINGS.*

By C. PURDON CLARKE, C.I.E., Keeper of the Indian Section, South Kensington Museum.

THE importation of partly manufactured material is at present exercising considerable influence over many of the native arts of Oriental countries and India. The supply of machine-made thread has doubled the village handlooms in some districts of Madras, and gold thread from Germany has enabled the brocade weavers to compete with the imitation brocades sent in from Europe. In some handicrafts, however, the supply of European material has produced a contrary effect. Iron and steel, bar and rod, have displaced an ancient industry, and sheet copper and brass have robbed the founder of half his work. Formerly the only means of producing sheet metal was by hammering cast plates, an expensive method, only resorted to when thin flat coverings were required for wooden or other objects. For very large vessels, where weight was required to be kept down and strength maintained, hammered sheet was used; but generally the founder was employed, to save as much as possible the labour of forming the furnished castings which required but little beating out, trimming, and brazing. In the case of a bowl, or flat jar with a narrow mouth, the founder would prepare a cast not unlike in shape and thickness that of an ordinary flower-pot saucer, from which, by constant hammering, the bulbous sides would be formed, projecting beyond the rim, which would remain of its first diameter and thickness. When finished such a vessel would be nearly double the size of the first cast, and a remarkable example of the native knowledge of the composition of bronzes and annealing processes. It is worthy of noting that the chief means of detecting modern from old Persian and Saracenic metal vessels is by examining the brazing joints, which in ancient vessels are rare. When not found, a close examination will show the vessel to be a thin casting, the ornamentation being by inlay or chasing and hammering, which, being done after the cast is made, gives the reverse side the appearance of chased sheet metal.

So far as I could ascertain, there are three methods of casting practised in India. The first by moulds in sand; the second, moulds in clay not unlike plasterers' piece-moulds; the third, clay moulds formed on a wax model, the *cire perdu* of Europe. The first of these is well known in Europe, but the second is, I believe, now described for the first time. In preparing the mould, impressions of the various parts of the pattern are taken in clay, and these pieces when nearly dry are, after trimming, stuck neatly together, and kept in place by several layers of mud, in which some fibre is mixed. The mould when ready has but one vent, which, placed on the most convenient side, is carried up into a sort of bottle neck. If the object is small several moulds are attached together, and the vents united by a single short neck of clay, to which a crucible, enclosed in an egg-shaped ball of clay, is attached. The size of this crucible depends upon the exact amount of metal required to fill the mould or moulds; and this quantity being known by experience, the founder places it inside before closing up. No provision is made for the escape of air from the mould when the metal is poured in. The mould and crucible (now in one piece) is allowed to dry; and after several coats of clay, tempered with fibre, have also been well baked on by the sun, the furnace is prepared. This is simply a circular chamber about 2ft. 6in. in diameter, 2ft. in height, with a perforated hearth and no chimney. Half filled with charcoal, a good heat is obtained by the use of several sheepskin bellows from beneath. When ready, as many moulds as the furnace will hold are placed in it, the crucible end of each being embedded in the fire. A cover is placed over, and the fire kept up until, upon examination, the moulds are found to be red hot. They are then taken, one at a time, and replaced in a reverse position, the crucibles being now above. The metal flows down into a red-hot mould, and penerates the finest portions of the surface without suffering from air or chilling. The fire is allowed to gradually cool, and when the objects are broken out of their clay covering, the metal is soft and malleable.

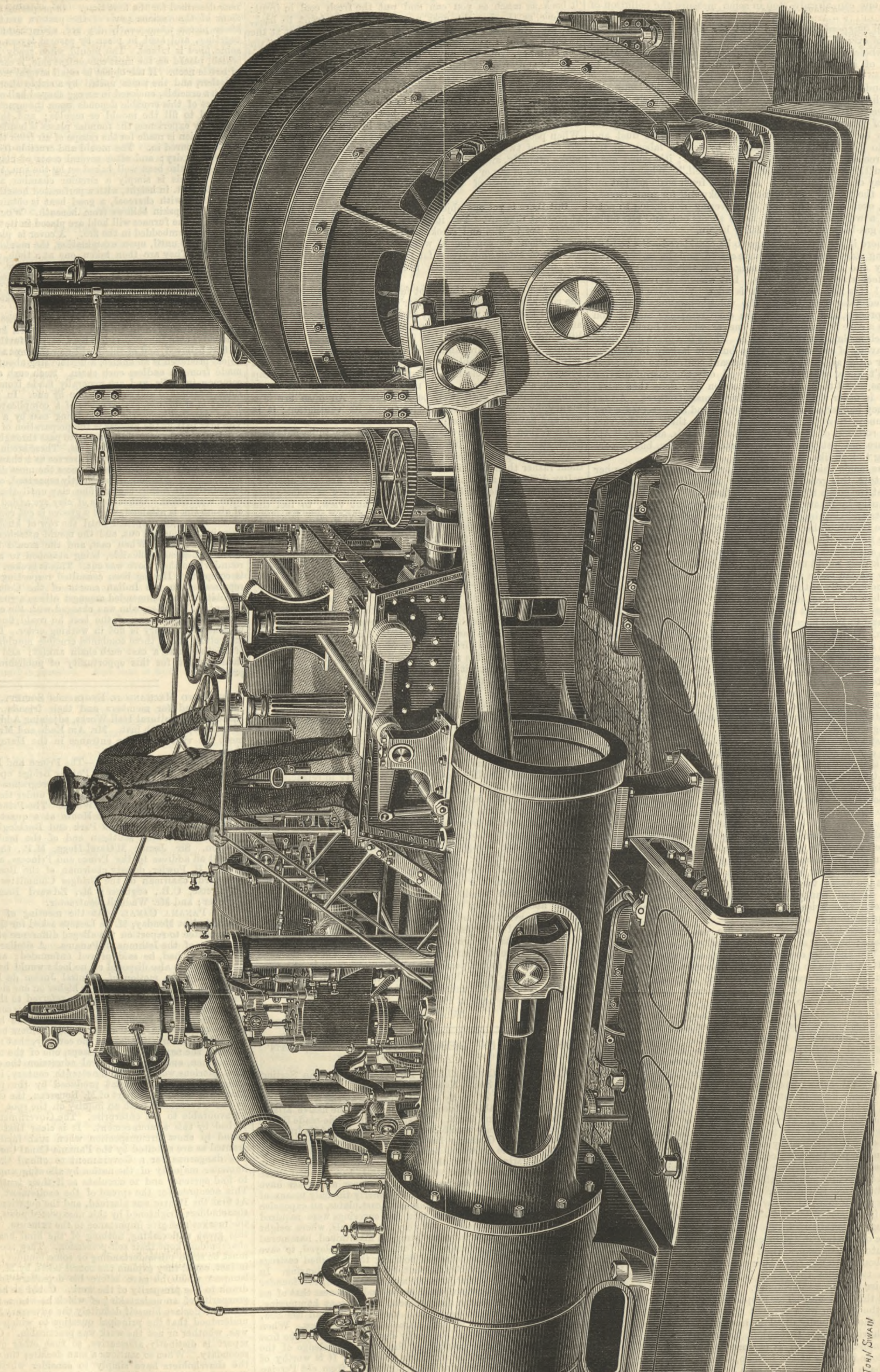
The third manner of casting—that by the use of a wax pattern which is destroyed in the moulding—is well known, but in one particular case the process has been carried further than would be at first believed, and of this I will now attempt a description. The object produced is an anklet, a flexible ring about 4in. in diameter, made from an endless curb chain. Such curb chain trinkets are common in India, and are generally made from thick silver wire rings interlinked and soldered one by one. In this example the anklet is of bronze, and consists of a complicated chain of forty-three detailed links, the whole being cast by a single operation. The first part of the process is the preparation of a pattern in wax, a delicate work, each link having to pass through four others, and to bear three small knobs or rosettes. These are in two instances but ornaments; the third, however, serves as a channel for the metal to enter each ring. Then commences the most difficult part of the work, each ring having to be slightly separated, and this is effected by painting in a thin coat of fine clay until there is sufficient to form a partition. Other coats of clay are added until a thickness of about ½in. is attained, when a groove is cut round the upper side of the ring, and deepened until the row of knobs is bared. The wax is then melted out, and the mould attached to a crucible as before described. When cast, and the mould broken away, the chain comes out inflexible, being attached to a rod which runs round where the groove was cut. This is broken off, and the chain is complete. Having been consulted respecting the trades to be represented in the Indian courts of the Colonial and Indian Exhibition, I recommended amongst others a good brassfounder to be sent. Dr. Tyler, who was charged with the collection of these artisans, engaged one of the best he could find, but up to the present the foundry is not in working order. I submit for your inspection one of these combined crucible moulds, with fragments of another, also a cast curb chain anklet; and now conclude by thanking you for this opportunity of publishing an interesting process.

* Iron and Steel Institute.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—Permission has been granted for members and their friends to visit the new National Agricultural Hall Works, adjoining Addison-road Station, to-morrow, the 29th inst. Mr. Am Ende and Mr. Walmisley will meet the visitors at the entrance in the Hammersmith-road at three p.m.

THE NEW PUTNEY BRIDGE.—The Prince and Princess of Wales will formally declare the new Putney Bridge open to the public to-morrow—Saturday—afternoon. A programme of the route and opening ceremony has been drawn up under the superintendence of the Metropolitan Board of Works. The Prince and Princess of Wales will leave Marlborough House at a quarter to four o'clock, and proceed by St. James's Park and Buckingham Palace-road, passing over to the southern end of the bridge to a covered pavilion. Sir James M'Garel-Hogg, M.P., the chairman, will present an address to the Prince and Princess, and introduce Mr. Francis H. Fowler, deputy chairman of the Board; Mr. William Shepherd, chairman of the Bridges Committee; Sir Joseph W. Bazalgette, C.B., engineer; Mr. Edward Bazalgette, assistant engineer; and Mr. Waddell, contractor.

THE PANAMA CANAL.—At the meeting of the Academy of Sciences, last Monday, M. de Lesseps asked for the appointment of a committee to report on the alleged difference of sea level on the two sides of the Isthmus of Panama. A similar objection to the Suez Canal had, he said, proved unfounded; and if the present objection were also disposed of, no locks would be necessary in the canal. On the motion of Admiral Jurien de la Graviére, who suggested that the tides might be higher on one side of the Isthmus than on the other, the question was referred to the navigation and astronomy sections. Considering, says a *Times* correspondent, that the shares of the Panama Canal Company are held in France by nearly 400,000 persons, that these shareholders belong to the most influential and trusted class in the country, that the work is bound up with the name of M. de Lesseps, one of the most honoured of Frenchmen, and that by general admission the canal will be the most glorious work of the nineteenth century, it will be easy to understand the excitement produced by the paragraph in the *Temps*, in which the report of M. Rousseau, the engineer intrusted by the Government with an inquiry on the spot, was stated to be unfavourable to the enterprise. The Government itself was disturbed by this announcement. It is clear that a Government is bound to show circumspection when such facilities have to be granted as are solicited by the Panama Canal Company. It is no less dangerous for a Government to offend the opinion of the immense majority of the nation by allowing unpleasant rumours to find currency and to circulate as if their truth were admitted. This accounts for the spread of the excitement just referred to. At first the Bourse was alarmed, and the question was asked if the shareholders, frightened by this unexpected news, would rush into the market and give importance to the rumours. Fortunately for this great undertaking, nothing of the kind has occurred. The shareholders kept their self-possession. They soon felt that there must be some misundertanding or some blunder; how otherwise, in fact, could they explain the course taken by M. Rousseau? At a banquet which he gave before his departure from Panama, he drank to the prosperity of the work. Could he have drunk to the prosperity of an undertaking of which he was a few weeks afterwards to declare himself definitely the adversary? Besides, it was understood that the principal question to which he had to reply was, whether or not the work was practicable. On this point his report is distinctly affirmative, so that other questions become secondary. When so cautious a man declares the work practicable, the shareholders have simply to consider whether they should flinch from the difficulties yet to be overcome. M. Rousseau was bound to make reservations, and he would have shown great heedlessness if he had not seen the difficulties of the enterprise. This is the real state of the case, and it has allayed the "sensation" originally produced. The shareholders have made a stand, and stopped the fall; while the Government seems inclined, on hearing the company's replies to M. Rousseau's objections, to follow the stream of public opinion and grant the facilities asked for by the company. It feels the necessity for putting an end to the uncertainty, and, as it is affirmed, it will shortly sanction the lottery debentures. Those who have watched the enterprise with interest will rejoice at this solution.



COLLIERY WINDING ENGINE FOR THE AUSTRALIAN AGRICULTURAL AND MINING COMPANY.

CONSTRUCTED BY MESSRS. TANGYE, BIRMINGHAM.

(For description see page 410.)

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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 H.—*See Stoney's book "On Stresses in Girders." London: Longman and Co. Adams' "Strains in Ironwork." London: E. and F. N. Spon.*

R. A. S. (Cardiff).—*The drawings you refer to are those of Mr. Wiswell's Tilting Weir at Throstlenest, Manchester, published in* THE ENGINEER *for September* 1st, 1882.

BRACED PIERS FOR BRIDGES.—*See "Graphic and Analytic Analysis," by R. H. Graham. London: Lockwood and Co. See also "Braced Piers for Bridges" in* THE ENGINEER, *vols xlix. and l, p.* 435, *and pp.* 89, 181, 241.

LANCASTRIAN.—*To calculate moments for all the various conditions of pressure, momentum, &c, would occupy far more time than we can spare—several days, in fact—but having once laid down a set of conditions you can calculate them for yourself. You will find the question well treated in a paper "On the Strength of Crank Shafts," read by Mr. J. Milton before the Institution of Naval Architects in* 1881, *and published in* THE ENGINEER *for April* 15th, *page* 271.

ENAMELLING IRON.

(*To the Editor of The Engineer.*)

SIR,—I want information concerning the above, or can any of your readers tell me of a book describing the process. ENAMEL.

STEEL CASTINGS.

(*To the Editor of The Engineer.*)

SIR,—I have a casting to make in steel in which I wish to core out holes ¾in. diameter and 24in. long. At present I have quite failed to get anything to stand, and the castings have therefore been spoilt. Is there any material or method by which such could be made?

May 26th. OPEN HEARTH.

[Try a core made of pulverised chrome ore and lime. A core made of Dinas fire-clay, properly burned, ought to stand.—ED. E.]

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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.*

MEETING NEXT WEEK.

COLONIAL AND INDIAN EXHIBITION CONFERENCES.—Friday, May 28th, at 3 p.m: Conference of the Royal Colonial Institute. Paper by Mr. F. B. Labilliere, "Imperial Federation." Monday, May 31st, at 4 p.m.: Paper by Mr. P. L. Simmonds, "Our Colonial Wool Supplies." Tuesday, June 1st, at 4 p.m.: Conference of the Anthropological Institute. "Native Races in British Possessions in Africa." At 8.30 p.m: Lecture by Mr. F. W. Pennefather, "A Tour through New Zealand," with limelight illustrations. Wednesday, June 2nd, at 4 p.m: Paper by Mr. S. B. L. Druce, "Importation of Grain and Bread-stuffs from the Colonies and India." Thursday, June 3rd, at 4.m.: Paper by Mr. Arnold White, "South Africa as a Field for the Emigration of the Industrial Classes."

THE ENGINEER.

MAY 28, 1886.

THE COLLINGWOOD ACCIDENT AND OUR GUNS.

How can Mr. Campbell Bannerman form a new committee to go into the question of our guns such as appeared to be contemplated by the members of the House? In our issue of May 7th we mentioned the peculiar constitution of the committee that had been assembled to decide what steps should be taken to enable our guns to utilise the tempting powers afforded by the ever slower and slower burning powder, while keeping within the limits of safety. The bursting of certain smaller guns forward, coupled with the obvious tendency of affairs, were matters of sufficient importance to make it desirable to call in all available orthodox counsel, both for the sake of its genuine value and, we suspect, also for the sake of involving all orthodox authorities in the responsibility of what might be done. The Ordnance Committee was reinforced on that occasion by the judgment of Elswick, as represented by Sir W. Armstrong and Captain Andrew Noble, of Whitworth's by Mr. Leece, of the Gun Factories by Colonel Maitland, and of the Chemical Department by Sir F. Abel. Thus we have gun construction, steel making, and research as to explosives, represented by the most powerful authorities. Truly on this occasion our War Department was wider awake than usual. What orthodox men possessed of practical skill remain to be called in? Mr. Vavasseur undoubtedly might be named. He saw the Collingwood accident too, an advantage if anything is to be learned by propinquity; but he now belongs to the same firm as Armstrong and Noble, and practically his nomination would not be in the direction of the demand raised. Mr. Rendel comes under much the same category, though he is no longer connected with Elswick. We can hardly think of one orthodox authority who is not more or less committed to any mistake we have made. Shall we take a new departure, and muster what we may with truth call a dissenting committee, unshackled by official trammels, unhampered by any connection with our past? We might invite, say, Messrs. Longridge, Lynal Thomas, Anderson, and Palliser. We might go further and call in Col. Hope. Could any other names be suggested for a new committee? We should look forward to scope for some startling and interesting writing if such a committee were assembled. The question, however, is a serious one for the War Department and for the country. Let us consider it; first, as to the position in which the matter stands, and then as to the steps we have taken.

We hold that England's position is peculiar. In quality we are really ahead of other Powers, if it be judged by actual achievements. Elswick nearly ten years ago sent out for service, guns firing projectiles with a total energy which scarcely Krupp, and certainly no one else, has rivalled to this day; and, in gun development, nine or ten years is a long span. To come to definite facts and figures. In 1876 the Armstrong 100-ton muzzle-loading gun was fired at Spezia with about 33,000 foot-tons energy. In 1879 Krupp with a 71-ton gun obtained 34,500 foot-tons; but by this time an Armstrong muzzle-loading 100-ton gun had accomplished 43,920 foot-tons. In 1882 the Armstrong breech-loading 100-ton gun achieved 46,640 foot-tons. Krupp's gun was, for its weight, a remarkable one; but it was long, we believe, a solitary experimental piece. Armstrong has for years been delivering 100-ton guns, which are mounted for service in the Italian war ships Duilio, Dandolo, Italia, and issued for the Lepanto. Krupp has now made four 119-ton guns, said to command an energy of 46,061 foot-tons; but there is some delay about their actual delivery, and they are not yet expected. In the meantime Elswick has gone on with 105-ton guns in progress for the Lauria, Doria, and Morosini, twelve in all; and two 110-ton guns for the British Benbow, the latter to have an energy of 61,190 foot-tons. So much for big guns. These are the best to take, because the bare facts and figures are readily grasped; and surely very large guns try the powers of manufacture and quality of steel most severely. Krupp has very excellent long guns of smaller bore, but so have we; and if experimental guns are to be taken we might instance our steel wire or riband guns, and we know of nothing that comes near them in power in proportion to weight. The service standard is, however, more sure. It is a fact that three Italian men-of-war are now carrying English 100-ton guns on service, to say nothing of those that are nearly finished; that 100-ton guns are in battery at Malta and Gibraltar, and if we look through the world we can find nothing to approach them anywhere. It is right to insist on this fact when so many of us are ready to run down what we have ourselves. We might go further, and say that in price as in power we stand ahead of all. Our power is greater, our price is lower than that of German guns, and no others can yet be compared with ours.

We have spoken of quality only so far; if we come to quantity we are undoubtedly behind. This concerns our Government more than our powers of manufacture. We waited too long before making steel guns, and now, to recover our lost ground, we have to make guns of various types as fast as we can, and we grapple with steel at once on a large scale, and make mistakes wholesale in consequence. We are brought now face to face with failure in a large 43-ton gun, and we have had several before with smaller pieces. We do not want to make little of this. The circumstance that we have insisted on putting the favourable side of our gun manufacture forward ought to enable us to speak plainly and strongly in the opposite sense when necessary.

To what is such failure to be attributed? It must be either wrong calculation or fault in manufacture. Mr. Anderson would say, and naturally, that he has maintained that we have entirely under-estimated the strain in the forward part of the gun; that he spoke as plainly before the event as it is possible to do now; and that he has a right to command attention. This position we think is valid, and we ought to give weight to what Mr. Anderson may say, though, of course, not necessarily to adopt his conclusions. Before we had the new powder, our guns were more liable to yield in other directions, and this does not suggest the total disproportion he complains of. Other causes undoubtedly act to produce exactly the result to which Mr. Anderson's conclusions point; but he may fairly urge that we certainly did not mean to burst our gun, and that consequently it follows either a gross failure in metal has escaped our observation, or else a miscalculation has been made, or both have combined to bring about misfortune. If the fragments could be all recovered, there would be the means of detecting a flaw in the metal. Two fragments have come to Woolwich, but most are lost we believe, so we may not learn much. Of course unless there is a flaw somewhere, or some exceptional action discovered, all the authorities in England will not convince us that their calculations were correct. They were aware of the increasing strain liable to be thrown on the forward part of our guns, and considered that they made allowance for it. As pointed out in our article of May 7th, the batch of guns to which the Collingwood piece belonged were in a sense superseded, but they were unquestionably believed to be equal to more strain than was thrown upon this gun. Pronounced safe for a charge of 295 lb., it burst with one of 221¼ lb.

Many suggestions are, of course, made to account for the bad and unexpected behaviour of this gun. Softer steel, we are told, should be employed, and it should be differently treated. An abrupt shoulder is a source of weakness; steel shafting is known to go from such a cause. The front hoop would cause such a shoulder, and by gripping the tube would make matters worse. Then, again, cylinders in hydraulic machinery subjected to such pressures as 2 tons per square inch are never considered safe unless they are hooped. Any of these arguments may deserve consideration; but there can hardly be anything in them that was not well known to those who designed the Collingwood's guns. On the last point we may naturally be inclined to lay stress, because hooping was the principle that we said enabled steel to be safely substituted for coiled iron in our articles on gun manufacture in 1880—especially in THE ENGINEER for July the 30th. Three advantages may specially be claimed by a hooped tube over a single one of the same thickness: (1) Shrinkage enables the outside to bear its share of the strain better. (2) The power of inspecting the metal is much greater, and therefore the chance of a flaw existing is much decreased. (3) Should a flaw nevertheless exist, its effect only extends to half the thickness of the tube instead of the whole.

The matter will be investigated, we believe, by the same committee that before met—we could hardly suggest any other course. They possess almost all the experience with steel gun tubes in the country, and are too widely representative to be committed to any particular system. They will probably recommend the hooping principle to be carried further, and the guns to be still further strengthened forward, and no doubt they may arrive at important precautions and tests. Much more than that, we fear, is hardly likely to follow; but we hope it will be sufficient. This will be a specially favourable time for Mr. Anderson and the others we have mentioned to put forward their views. Foreign critics will naturally and properly watch the matter closely, and see how we progress in our ordnance manufacture; but from what we have said, it may be seen that we can afford to bear this. We have less experience in steel tubes than Krupp, but this fault will mend rapidly, and everything has not been going smoothly with guns on the Continent. Enormous things are now expected of guns, and difficulties and failures must be met with occasionally. These we hope to grapple with, and to maintain the high standard we have long attained with our heavy, and latterly with our medium guns.

THE ANNUAL REPORT OF THE METROPOLITAN BOARD.

WITH a jurisdiction extending over four millions of people, and that population growing at the rate of 65,000 per annum; with a basis of rating which now exceeds £30,000,000, and with a yearly income of more than £1,700,000, accompanied by a debt of £17,000,000, the Metropolitan Board of Works may well present an Annual Report containing something worthy of consideration. To many people the government of London is an inscrutable mystery. In defence of the system as it is, it may be argued that the very ignorance of the average Londoner as to the method by which he is governed affords proof of its excellence. The machine works so smoothly, that he cannot tell where or what it is. He simply has to pay, and he need trouble himself no farther, unless he chooses. If the dust blows freely in the streets, or the mud and snow annoy him in the winter, or if the water supply runs short, or the gas burns dimly, or the drains get choked, or the dustman forgets to call, the householder, or other aggrieved party, can write to the newspapers, and if his letter appears, he rests assured that an effect will follow. At all events, the sufferer will have some vent for his feelings, and with that he will probably be satisfied. As for hunting up the Vestry, or the District Board, or the Metropolitan Board of Works, only a small minority will ever undertake such a task. It is easier and more dignified to "write to the papers," and so add to the impetus whereby the press is generally running a-tilt against the local authorities. These said authorities are not faultless; but whether London will ever see any much better than those which now exist is a matter for speculation. If only the ruling powers will be honest, we may allow them to be a little stupid. As the grandest outcome of local self-government in London, apart from the Lord Mayor and the Corporation, we have the Metropolitan Board of Works. In the matter of display this Board is denied the mediæval splendour which appertains to the ancient civic authorities. The Imperial Government exercises an occult influence over it, helping it on the one hand and snubbing it on the other. The Board is threatened with extinction, but still it lives; and its continued duration is favoured by the political turmoil which now so largely affects the state of public affairs. Sir James McGarel-Hogg, M.P., has once more given his annual banquet as Chairman of the Metropolitan Board, with royalty, nobility, and high dignitaries to give him countenance, the Lord Mayor himself being present as a distinguished guest. So far as we can see the feast may be often repeated, and assuredly the banquet of the other day will not be the last of its kind. The Board has added to its strength during the past year by enlarging the representation, the number of members being augmented by more than a dozen, equal to an addition of about one-third. The darkest feature in its future is probably the threatened discontinuance of the coal duty. This tax expires in 1889, and if it were extinguished now, the rate levied by the Board for 1886 would be 9½d. instead of 7d. Those who pay the rates, and who are not engaged in processes requiring a large consumption of coal, prefer that the coal duty should be renewed. It is clear there are other interests which prefer that the coal duty should die a natural death. The theory which governs local taxation in the present day is opposed to the nature of a coal duty, and we may expect to see this impost expire. It has done good service in its time, and the money is still wanted; but the Board will apparently have to do without it.

There can be no doubt that the cessation of the revenue from the coal duty will be a check to the progress of metropolitan improvements. From this source the Board now derives as much as £300,000 per annum. The wine duty may be left out of consideration, as yielding only a very small amount. The coal duty not only affects the income of the Metropolitan Board, but also of the Corporation, the latter body taking fourpence per ton, and the Board ninepence. According to a Parliamentary return issued a few days ago, the quantity of coal carbonised last year by the three London gas companies was 2,325,176 tons. Hence these three companies would benefit by the extinction of the coal duty to an extent considerably exceeding £100,000 per annum. Some suburban gas companies would also be relieved by the cessation of the duty, its incidence extending to localities outside the metropolitan boundary. The practical value of the coal duty has been shown in the past by its aid in the formation of the Thames Embankment, and the extinction of the tolls on the metropolitan bridges. Three years ago the Board endeavoured—not for the first time—to obtain support from the Government to a proposal for a prolongation of the coal and wine duties, but met with a refusal of such a nature as to occasion the abandonment of some costly works which the Board had previously contemplated. The projects thus surrendered included the widening of Parliament-street and improving the approaches to the new Law Courts. Additional means of communication across the Thames below London Bridge had long been recognised by the Board as a necessity, and in 1883 the plans contemplated for adoption included a high-level bridge between Little Tower-hill and Bermondsey, a tunnel between Shadwell and Rotherhithe, and a tunnel between Blackwall and the vicinity of Greenwich and Woolwich. The total estimate was £5,000,000. Discouraged by the policy adopted at the Treasury, the plans of the Board subsided into a scheme for a subway or tunnel under the Thames from Nightingale-lane on the north side to Dockhead on the south. Further down the river it was proposed to establish two steam ferries for the conveyance of vehicles, with proper approaches on each side. In 1884 Parliament rejected the project for the subway, and the Board withdrew the proposal for the establishment of the steam ferries. In a special report to the House of Commons, announcing the result of the inquiry, the Select Committee before whom the proposals of the Board had been laid expressed an opinion that two crossings over the Thames were immediately required, and should be sanctioned by Parliament. One was to be a low-level bridge at Little Tower-hill, with two openings, to be spanned by a pivot swing bridge. As the Bridge House Estate was possessed of funds, the Committee expressed a hope that the Corporation of the City would undertake the building of the bridge, and that the Board would construct a subway at Shadwell. The Board, however, saw fit to let the subway alone, and limited its ambition to two steam ferries, one between Greenwich and Poplar, and the other between Woolwich and the opposite shore. The Corporation, on the other hand, resolved to undertake a bridge at the Tower, and having obtained parliamentary sanction, they are now proceeding with the scheme, the Prince of Wales undertaking to drive the first pile on June 21st. Our opinion of this bridge is well known to our readers. Less fortunate than the Corporation, the Metropolitan Board only succeeded in getting its Woolwich ferry fairly through Parliament last year, the Select Committee of the House of Commons, and also the Lords, requiring such compensation to be given in respect of existing ferry rights at Greenwich that the Board refused to consent, and therefore abandoned that part of its project. After all the expectations previously entertained, and the magnificent plans espoused, the schemes of the Board for crossing the Thames below London Bridge resolved themselves into a steam ferry at Woolwich. Higher up the river the Board has been more successful. A new bridge has been built at Putney, and is to be opened to-morrow under royal auspices. Hammersmith Bridge is being re-built, and a new bridge is just about to be commenced at Battersea.

The proceedings of the Board with reference to the main drainage outfalls of the Thames have lately been described at some length in these columns, thereby rendering it unnecessary for us to repeat the record of last year. It is, however, desirable to notice the grounds on which the Board has based some of its decisions. Reference is made to the project which Sir Joseph Bazalgette laid before the Royal Commissioners, for conveying the sewage to Thames Haven. The report states that it was by no means clear to the Committee of the Board, especially when consideration was given to the estimates of cost, that the carrying of the sewage to Thames Haven would be either the most effective or the most economical way of dealing with it. There was also the danger of local opposition, as promptly shown by the protest of the Southend Local Board. Concerning the Canvey Island scheme devised by Lieutenant-Colonel Jones and Mr. Bailey Denton, the proposal that the Board should deliver the whole of the London sewage over to Messrs. Jones and Denton, and should make them an annual payment of £110,000, was held to be inconsistent with the duty of the Board, and as a method by which its responsibility could not be evaded. To meet this objection, Messrs. Jones and Denton subsequently offered to transfer to the Board a right of option which they had obtained for the purchase of about five-sixths of the area of Canvey Island. On this point we are told—"The Board, however, was not of opinion that it was either necessary or desirable that it should become the possessor of this land." With respect to the proposal of Mr. J. O. Phillips, on behalf of the Gas Light and Coke Company, to carry the sewage sludge out to sea in the Beckton colliers, the report says: "Upon examination, however, it was found that the expense which the acceptance of this proposal would involve was greater than was necessary for effectually disposing of the sludge, and that it would be better for the Board to endeavour to deal with the sludge independently." Leaving this topic, and proceeding to a consideration of what the Board has to say on the subject of the water supply, we meet with a strong expression of regret that the Bill, whereby the Board was to have power to introduce a scheme for purchasing or superseding the existing water supply of the metropolis, failed to reach a second reading. We may add that the Bill introduced for the same purpose in the present Session has been thrown out in a very decided fashion, and the prospect that the Board will have any power to interfere on the main question as to the water supply of the metropolis is now more remote than ever. The Board can still oppose measures relative to the water supply, though it is not permitted to initiate anything of that nature. Thus it has effectually prevented the Kent Company from furnishing a supply of water to certain localities outside the original boundaries of the company, the inhabitants of which were anxious to enjoy such a provision.

At the date of the report the Board was still engaged in acquiring property required for the formation of the new street from Tottenham Court-road to Charing-cross, authorised by an Act passed in 1877. The law, as originally framed, placed obstacles in the way of the Board, which occasioned this lamentable delay. The same remark applies in respect to the new street from Piccadilly-circus to Oxford-street. The wisdom of Parliament has singularly failed both with regard to new streets and the erection of artisans' dwellings. A strange financial history appertains to the latter. The Fire Brigade also furnishes a striking illustration of how awkwardly our Acts of Parliament sometimes work. While enormous sums have been lavished in order to provide dwellings for the working classes, the Fire Brigade has been stinted to a miserable halfpenny rate, supplemented by a grant from Government, and a contribution from the fire insurance companies. There is a Bill before Parliament which, if it passes, will set this matter right; but it is only too possible that the Bill may drop through again as it has done before. The Metropolitan Board requires an increased scale of contribution from the insurance companies, and the friends of the latter are blocking the Bill. The Home Secretary takes sides with the fire offices, and unless the Board consents to withdraw its demand upon the latter, the Fire Brigade may continue for at least another year in its present embarrassed condition. A pleasant feature in the report consists in the account which it gives of the 1834 acres of parks, commons, and open spaces under the Board's control, in the maintenance of which about £22,000 were expended last year. There are many other items in the Board's report, including such widespread subjects as petroleum, tramways, gas supply, telephone and telegraph wires, infant life protection, theatres and music-halls, slaughter-houses, explosive substances, and cattle diseases. The duties of the Board correspond to the magnitude and complexity of the metropolis, and we can only wonder at the story that will have to be told if ever the metropolis should come under the control of one great municipal authority, having charge of water, gas, and other huge interests in addition to those already controlled by the Board at Spring Gardens.

THE ROYAL AGRICULTURAL SOCIETY.

THE Royal Agricultural Society is beginning to feel the effects of its suicidal policy. For some time past English agricultural engineering has increasingly suffered through the decadence of the useful activity of the Society. Without giving up the position the Society held and nominally holds for the encouragement of the combination of "practice with science" in agriculture, it has ceased to do the work. It has now itself ceased to grow, and has commenced on its downward path towards its own extinction. The report read at the annual meeting held last Saturday showed that there was during the past year a decrease in the number of members. A decrease in the number of members of a society of this kind indicates the cessation of its popularity, and that there must be some cause for so large a decrease as 173 members. The fact is the Society no longer offers the attractions it once did. It has given itself up to the sophistic arguments of a harmful section of its council, and its work in the encouragement of the manufactures of its best supporters has become nominal and trivial. In the report the council lament that the cheesemaking prizes offered at Preston last year did not attract more than two competitors. Perhaps next year's report will lament that only one competitor appeared for the prize for rings for pigs' noses, or in some other equally wide field for the exercise of ingenuity, without running the risk of calling forth the wrath of some of the makers of the implements which gained them prizes a generation ago. The Society must look to itself ere its backsliding ends in the complete loss of its prerogative and the assumption of its position by one which is doing, as all healthy societies should, namely, increase in numbers. Substantial prizes should now be offered, and properly conducted trials made of steam engines, steam ploughs, thrashing machines, and food-preparing machinery. Is the Royal Agricultural Society going to do this, or will it allow itself to sink entirely into insignificance by the suicidal policy of the past ten years? The Norwich meeting will begin on Monday, July 12th, and close on the 17th, but the implement yard and working dairy will be open to the 19th. It has been decided that the country meeting of 1887 shall be held at Newcastle, and the country meeting for 1888 in the district including the counties of Derby, Leicester, Lincoln, Northampton, Nottingham, and Rutland.

LITERATURE.

Mineral Resources of the United States. Calendar Year 1883 and 1884. By ALBERT WILLIAMS, jun. 8vo., pp. 1016. Washington: Government Printing-office. 1885.

THIS volume is the second of the series of statistical publications having special reference to the mineral production of the United States, issued by the newly organised Federal Geological Survey, and deals with the output of the years 1883-84. In the first volume of the series the results for 1882 were given, together with an estimate for the first half of 1883, so that to some extent the two volumes overlap, but in other respects they are independent. The results abstracted from the general summary given in the introduction are as follows:—

	Quantities.		Value.	
	1883	1884	1883	1884
			Dols.	Dols.
Pig iron, tons	4,595,510	4,097,868	91,910,200	73,761,624
Silver, troy ozs.	35,733,622	37,744,605	46,200,000	48,800,000
Gold ,, ...	1,451,249	1,489,949	30,000,000	30,800,000
Copper, cwts.	1,045,909	1,207,339	18,064,807	17,789,687
Lead, tons	128,533	124,908	12,322,719	10,537,042
Zinc, tons	32,921	34,414	3,311,106	3,422,707
Mercury, flasks	46,725	31,913	1,253,632	936,327
Nickel, pounds	58,800	64,550	52,920	48,412
Aluminium, troy ozs. ..	1,000	1,800	875	1,350
Platinum, ,, ...	200	150	600	450
Value of metals			203,116,859	186,097,599
Coal, tons	68,531,500	73,730,539	82,237,800	77,417,066
Anthracite, tons	34 336,469	33,175,756	77 257,055	66,351,512
Petroleum, barrels	23,400,229	24,089,758	25,740,252	20,476,299
Natural gas			475,000	1,460,000
Value of fuels			185,710,107	165,704,872
Salt, lime, stone, clay, and other mineral products of all kinds			63,377,662	61,302,149
Total value			452,204,623	413,104,620
Or at 5 dols. per £ sterling			£90,440,926	£82,620,924

From these figures it will be seen that the fall in value of mineral products current in Europe has been no less marked on the other side of the Atlantic, and the returns for 1885, which are promised early in the current year, will doubtless show a further considerable diminution. The values in the grand total are also subject to reduction by the discount on silver, which is here taken at the mint coining price, whereas it is really worth about 25 per cent. less in the market. The production of lead has fallen off about 4000 tons in 1884, which represents the difference between the diminution in the four principal regions, Colorado, Nevada, Utah, and the Upper Mississippi Valley, together about 11,000 tons, and the increase of 7000 in the other Western States. The phenomenal region of Leadville, in Colorado, has declined from about 40,000 tons in 1882 to 35,000 tons in 1884. The rich and easily reducible carbonate of lead, forming the bulk of the ore when the mines were first opened, has now given place to mixtures of galena and blende, which are exceedingly intractable in the smelting furnace.

The chief feature of interest in the statistics of copper is the rapid advance in the production of this metal in the United States, the increase having been about eightfold, from 8000 to 63,500 tons between 1864 and 1884. Three principal districts have contributed to this increase, namely, Lake Superior, the Butte district of Montana, and Arizona, the first figuring for about 69 millions of pounds, the second for 40½ millions, and the third for 26¾ millions, in the returns for 1884, out of a total of 142¼ millions. The Lake Superior region, though still paramount, now gives less than one-half of the total, though a few years back it supplied from 85 to 95 per cent. This is due chiefly to the rapid growth of the Butte district, where rich sulphides are produced in enormous quantity and smelted on the spot to a 65 per cent. regulus, much of it containing silver, which is almost entirely exported to refiners at a distance. The Lake Superior mineral, on the other hand, is entirely native copper diffused through rock, and is entirely smelted and refined on the spot, producing ingot copper of almost absolute purity. The Arizona minerals are in great part oxidised products derived from rich sulphides, red and black oxides, malachites, &c., having a general resemblance to those raised in the early days of copper mining in South Australia, although in some of the mines yellow ore and other sulphides are increasing in proportion with the depth of the working. Up to the present time the treatment has been a concentrating smelting to black copper, and a small amount of rich regulus, which are entirely exported. The circumstances of the district are peculiar, and necessitate the use of water-jacketted blast furnaces, the fuel used being in great part English coke imported by way of San Francisco. The first place among the copper mines is still kept by the Hecla and Calumet, of Lake Superior, which alone contributes about one-third to the total make of the year; but the Anaconda, a mine of Butte, seems to be rapidly advancing to a position of equality, as its dressing floors are laid out for the treatment of 500 tons of ore daily, and it is expected to produce from 12,000 to 15,000 tons of rich regulus in its smelting furnaces annually. In spite of the largely increased production, the consumption of copper in the United States has kept fairly in advance, 108 out of 142 millions of pounds having been retained for domestic use in 1884.

Zinc mining and smelting is restricted to a comparatively small number of localities, which are principally in Illinois, Kansas, and Missouri. The ore treated is now principally blende with some calamine derived from irregular deposits in limestone. There is also some production from the ores of Franklin in New Jersey, although that is principally converted into oxide for paint. The largest zinc works are those of Matthiesen and Hegeler, at Lasalle in Illinois, who have 3200 retorts in four double gas-fired furnaces, with capacity for production of 13,000 tons of spelter annually.

Mercury mining is practically restricted to California, and the account for the period under review is decidedly depressing. The number of active mines had diminished from thirty in 1876 to eleven in 1884. Of the total production of 31,913 flasks of 76½ lb., 20,000 were contributed by the New Almaden Mine, which alone works at a profit. This depression is in great part to be attributed to the competition of Spain and Idria, and also to the falling off in the demand owing to the substitution of smelting for amalgamating processes in the treatment of the ores of the precious metals. The excellent paper by Mr. Christy on the reduction furnaces at New Almaden, has been reprinted from the "Proceedings" of the American Institute of Mining Engineers, in connection with this subject, but its utility is diminished by the omission of the illustrations.

Tin mining is as yet a subject of only speculative interest in the United States, the ore having been found in minute quantities in many localities, but up to the present time in none of commercial importance. The most promising of these appears to be the Etta location, in the Black Hills of Dakota, where tinstone is found under conditions similar to those obtaining in Cornwall and Saxony. This part of the subject is extremely well treated by Professor W. P. Blake, of New Haven, one of the most eminent mineral geologists of America.

As regards the precious metals, the information is confined to an abstract of the report of the director of the United States Mint, who is specially charged with the statistics of those subjects. Iron and steel manufacture has been treated by Mr. J. M. Swank, of the American Iron and Steel Association, who gives, among other subjects, an excellent geographical analysis of the ore deposits of the country. The coal fields have been treated in the same way by Mr. Armstrong, and there is a very full account of the Pennsylvania coke trade by Mr. Weeks. Each of the non-metallic minerals comes in for a descriptive account, even where the production is insignificant and numerical returns are not available, so that the whole volume presents a very faithful picture of the state of mineral industry in all its branches on the other side of the Atlantic, and is likely to be permanently valuable even when the immediate interest of the returns for the year treated has gone by.

The volume, of more than a thousand pages, is in accordance with the statute founding the survey, issued at the price of publication, *i.e.*, cost of paper, printing, and binding, which is placed at the very low rate of sixty cents, or about half-a-crown. If it can be obtained at any moderate advance upon this price in England, it should have a large circulation here.

Constructive Geometry of Plane Curves. By T. H. EAGLES, M.A. Macmillan and Co. 1885.

THIS is a book which we can heartily recommend to teachers and students of engineering who wish to attack professional problems with some approach to scientific precision. For success in that endeavour nothing seems to be more advantageous than a thorough training in geometry, provided always that the geometrical theorems studied be applied practically to the solution of concrete problems. The study of what we may call "abstract mathematics" will do no scientific student much good; in fact, it may rather have an evil influence in forming a habit of believing that a knowledge of principles alone is sufficient to enable a man to do good work. Such a belief is entirely fallacious. But, on the other hand, if each theorem is carried out in the actual construction on the drawing board or in the modelling workshop of a number of illustrative problems, the student gets a real insight into the detailed facts and uses of geometry and mathematics generally which will be of immense value to him throughout his whole practical life. In his preface, Mr. Eagles expresses this opinion, and adds, with reference to existing methods of geometrical teaching, "A great deal of attention is devoted to the construction of regular polygons, circles packed into another circle, and similar fancy figures, by methods which no practical draughtsman ever uses." This is very true, and we only wish our author had carried his revolt against ancient geometric pedantry even further than he has, especially with regard to elementary constructions. If his volume had treated of solid as well as plane construction, he would probably have entered a similar protest against the inanities in vogue under the title "Descriptive Geometry." We entirely agree with some of his elementary instructions, *e.g.*, those regarding the dividing of straight and curved lines, but not at all with others, *e.g.*, in the drawing of a straight line between two ascertained points. The meaning and uses of harmonic ranges and of points in involution are explained early. In treating the circle, the pole and polar are introduced at the outset, and constant use is made of them in the series of problems given in this chapter. In explaining the properties of a system of two circles and those of a system of three circles, effective use is made of the "radical axis," the "centres and axes of similitude," and of the "radical centre." Passing on to conic sections, their properties are deduced in the ordinary manner, namely, from the constancy of the proportion of radius vector to distance from directrix. From the point of view of generality, of course, this is the most convenient method, but we cannot help regretting that in so good and practical a book a short preliminary chapter was not here introduced, dealing specially with the ellipse, and deducing its most important properties by considering the ellipse simply as a parallel projection of the circle. The ellipse is infinitely more important to physical students than the other conics, and engineers at least usually arrive at ellipses by projection of circles. Again, the properties of the circle are so familiarly known, and the passage to the corresponding properties of the ellipse by means of parallel projection is so eminently simple and easy, that it is a pity that this connection should not be elaborated until it becomes very familiar. Methods of constructing ellipses from given data are explained very fully. Thus, four methods of construction from given conjugate diameters are shown. In a later chapter MacLaurin's, Newton's, and Chaste's methods of drawing conics are proved. The pole and polar and the harmonic and anharmonic properties of conics are very fully dealt with. There are also chapters devoted to the more important special curves, such as cycloids, spirals, curve of lines, catenary, elastic curve, magnetic and equipotential curves. These, considering their extreme importance in all physical science, might have had advantageously more space given to exposition of their properties, and to graphic methods of making physical calculations depending on these. For instance, the method given for drawing out a catenary is clumsy and tedious. The book finishes with a chapter on the graphic solution of equations. This is a subject of high importance, especially for the solution of transcendental equations, those of high degree, and generally for equations of such difficulty that all ordinary algebraic methods fail. We hope this final chapter may be extended in a future edition.

We conclude by again recommending this volume to the attention of engineering students on all points it deals with, excepting only the technique of skill in draughtsmanship.

PRIVATE BILL LEGISLATION.

IF the widely prevalent rumours of a speedy dissolution of Parliament prove true, that will not occur without there being a good record of work done even in this short session in regard to private Bills. During the last few weeks these measures have been pushed onwards with vigour in the Committee rooms; at the same time opposition has given way in many directions, and thus the formidable array of private schemes presented in January last is rapidly dwindling away. Right and left opponents to Bills have been defeated before Committees, or mollified by promoters, or retired where further fighting only meant useless expense; and the next batch of measures stamped with her Majesty's approval will embrace a considerable number of private Bills. The apparently irrepressible Ship Canal Bill is still awaiting final treatment, but it is the only project of first-rate importance still to be dealt with. As we pointed out in our last article on these measures, the death of Earl Redesdale has benefitted the Canal Bill, for instead of deciding adversely to the payment of interest out of capital during construction, as they probably would have done had Lord Redesdale been with them, the Select Committee of Lords upon the proposed new Standing Order has reported in favour of such alterations in the present rules as will enable the Upper House to allow such payment of interest if they choose, just as the House of Commons can. Somewhat strangely, the only witness whom the Committee examined was Lord Rothschild, who is believed to be arranging to supply the capital for making the canal; and it may be assumed that he strongly advocated the change. The sequel to the decision of the Committee is that the Lord Chancellor proposes to amend the present prohibitive Standing Order of the House of Lords, so as to permit payment out of capital to be made on calls under railway, &c., Bills when the Committee on the Bill thinks fit to allow it—subject to the conditions that the rate of interest is limited to 4 per cent., that it is paid only during the time allowed for the completion of the work, that at least two-thirds of the share capital have been issued and accepted, that no interest is paid on shares in arrear, that the amount of interest paid be stated in the half-yearly accounts, and other precautionary conditions. Once more the Canal Bill seems to have a chance of success, but it has had so many vicissitudes that prophesying is dangerous. The promoters, at all events, are sanguine, and have lately been buttonholing as many noble lords as they could get hold of, with a view to winning their support.

The anticipations as to Lord Redesdale's succession as Chairman of Committees in the House of Lords were all falsified, for neither Lord Camperdown nor Lord Monson nor Lord Balfour of Burleigh was chosen, but the Duke of Buckingham and Chandos. That noble duke had not been in the least associated with such work, and the selection was a surprise; but his Grace has shown abundant energy and zeal at all events, since he assumed the duties. The following are among the private Bills most recently advanced a stage, and in regard to most of them it may be taken that they have now passed both Houses, and only await the Royal Assent:—Third readings in the House of Lords—Gowan and Portpatrick Junction Railway; Radstock, Wrington, and Congresbury Junction Railway (Abandonment); Solihull Gas; Wrexham Gas; London, Brighton, and South Coast Railway; Midland; Great Western of Ireland; London, Chatham, and Dover Railway; Great Northern Railway (Ireland); Kirkcaldy and Dysart Water; Liverpool United Gas Bills. Third readings in the House of Commons—Bray and Enniskerry Light Railway; Dublin, Wicklow, and Wexford Railway; Exeter, Teign Valley, and Chagford Railway; Sligo and Bundoran Tramway; Brighton and Dyke Railway; North Pembrokeshire and Fishguard Railway; Ormskirk Railway; Ripon Corporation; South Shields Gas; Bridgwater Railway; Leamington Corporation; Carlisle Corporation; Oldham Corporation; Sidmouth Water; East London Water; Lambeth Water; Southwark and Vauxhall Water; London, Tilbury, and Southend Railway: Guildford Corporation; Barry Dock and Railways; and Nottingham Suburban Railway Bills.

Since we last referred to them, the several London Water Bills have passed from the Committee back to the House of Commons, and there been read a third time, as mentioned above. In respect to the Southwark and Vauxhall Bill, it may be explained that apart from the question of raising additional capital, which was the chief matter of difficulty before the Committee, several important provisions have been sanctioned by the passing of the Bill. Among these the company is authorised, for the purposes of preventing and detecting waste, to affix stop cocks at the consumer's expense to all service pipes within its district connecting with its mains. The Bill also sanctions the construction of a reservoir at Forest-hill, together with the laying down of a line of pipes for the purpose of giving an adequate supply of water by gravitation to the highest parts of Wimbledon. The clause in the Bill concerning the compulsory purchase of the dust-sifting yard near the company's filter-beds at Battersea has been struck out, and in its place an agreement with the London and Brighton Railway Company, the owners of the dustyard, is scheduled to the Bill, in which an undertaking is given to discontinue its use as a dust-sifting yard upon certain terms contained in the agreement.

In the end the opposition offered by the Metropolitan Board of Works and the Tottenham Board to the River Lea Purification Bill was withdrawn, but not without conditions which very much transformed the measure. These, however, were arranged, and the Bill passed the Chaiman of Ways and Means as an unopposed Bill. The effect of the measure as now shaped was explained to the Metropolitan Board by Mr. Selway, who proposed the endorsement of the agreements made. He stated that the discharge of crude sewage was to be prevented; the effluent from Tottenham was to be allowed to enter the Board's sewer during the four hottest months of the year: and a standard of purity as regarded the effluent had been fixed by the Board's chemist. Penalties would be inflicted on the Tottenham Board if the effluent water to be poured into the sewer was not sufficiently pure. The duration of the agreement was limited to three years, and was subject to the power of extension for two years more, the Tottenham Board paying £1000 a-year towards the expenses incurred. As a result of this agreement he hoped the river Lea would be considerably purified this year, and that the water next year would be entirely pure. Mr. Selway further said the effluent would be discharged into the river during the cold and wet weather, when it was presumed it would cause no nuisance, until a comprehensive scheme was arranged for draining the whole Lea Valley, which was outside the area of the Metropolitan Board. The four hottest months of the year were deemed to be June, July, August, and September, but power would be given to allow the effluent to enter the sewer in May, if necessary, the period in September being proportionately shortened. This arrangement was sanctioned by the Board, and the Bill may be regarded as certain to pass.

The object of the London, Brighton, and South Coast Railway Bill, included in the list of third readings in the House of Lords, is to authorise the company to construct short junction railways at New Cross, to stop up level crossings at Mitcham and Edenbridge, to extend the time for the purchase of lands and for the completion of the Oxted and Groombridge Railway, to authorise the making of further agreements between the company and the Isle of Wight Marine Transit Company, and to make further provision as to the maintenance and management of the Southsea Railway.

The Various Powers Bill of the Metropolitan Board has also passed unopposed through the Committee stage in the Commons. By this Bill the Board are authorised to construct a foot bridge from the Thames Embankment to Hungerford Bridge, and to carry out certain street improvements in Lambeth and Newington. An extension of time is also granted for constructing the new bridge at Battersea, and further powers are conferred on the Board with regard to the already sanctioned park at Dulwich and the acquisition of Little Wormwood Scrubbs. The same good fortune has fallen to the Cricklewood, Kilburn, and Harrow-road Tramway Bill, the threatened opposition having collapsed. The Bill incorporates a company with a share capital of £100,000, and power to borrow £25,000 for the purpose of constructing tramways from Cricklewood along the Edgware and Kilburn roads, to a point near the Kilburn station, and thence along the Cambridge and Chippenham roads to the Harrow-road, and on as far as Lord Hill's Bridge.

A Bill has passed unopposed, empowering the owners of the Parliament Hill estates to sell, and the Metropolitan Board of Works to acquire, the lands known as Parliament Hill, Parliament Fields, the Elms Estate, and the East Park Estate, to be added to Hampstead Heath, and to be devoted for ever to the public use. The Corporation of London, the Charity Commissioners, the trustees of the London Parochial Charities, and certain vestries and local boards are enabled to contribute to the purchase money if they see fit. In like manner the Bill authorising the transfer from the Ecclesiastical Commissioners to the Metropolitan Board of twenty-two acres of land, comprising Little Wormwood Scrubs, to be devoted to purposes of public recreation, has been passed by the Chairman of Ways and Means.

After rousing a vast amount of public feeling, the Bill for empowering the Governors of Charterhouse to sell a portion of the property for building purposes in order to obtain funds to provide accommodation for an increased number of pensioners, came to an unexpected end. The Attorney-General (Sir Richard Webster) having moved the second reading of the Bill in the House of Commons, was met by Mr. W. James with an amendment deprecating the proposed "mutilation" of this interesting relic of Old London." A discussion ensued, followed by a motion to adjourn the debate. This motion was defeated, and then Sir R. Webster cut the Gordian knot by withdrawing the Bill voluntarily.

The Bill to transfer the Marquis of Bute's Docks at Cardiff to a limited company having weathered the storm of opposition before a Lords' Committee, has now got safely into smooth water, for the only remaining petition has been unconditionally withdrawn. As amended by the Lords, the Bill sanctions the transfer of the whole of the Bute Docks at Cardiff into the hands of a joint stock company, of which the first directors will be the Marquis of Bute, Lord Edmund Talbot, Mr. Frederick Pitman, and Mr. George Edward Sneyd. The capital of the new company will be 3½ millions, divided into 35,000 shares of £100 each. Of these 9000 will be 4 per cent. preference shares and 18,000 ordinary shares, the remaining shares being issued either as preference or as ordinary. The borrowing powers of the company are limited to £1,150,000, and in consideration of the transfer the following sums will be payable:—To the estate trustees of the Marquis 9000 fully paid 4 per cent. preference shares; to the Marquis himself 18,000 ordinary shares, fully paid, and 4 per cent. debenture stock to the nominal amount of £250,000; to the estate trustees sufficient debenture stock to raise the sum of £550,000, to be applied in the discharge of mortgages; to the Marquis certain royalties, &c., on shipments, rents, and dues. The transfer will take place from the 31st December next, and provision is made for the purchase of the company's stock by the corporation of Cardiff and the Great Western, Rhymney, and Taff Vale Railway Companies.

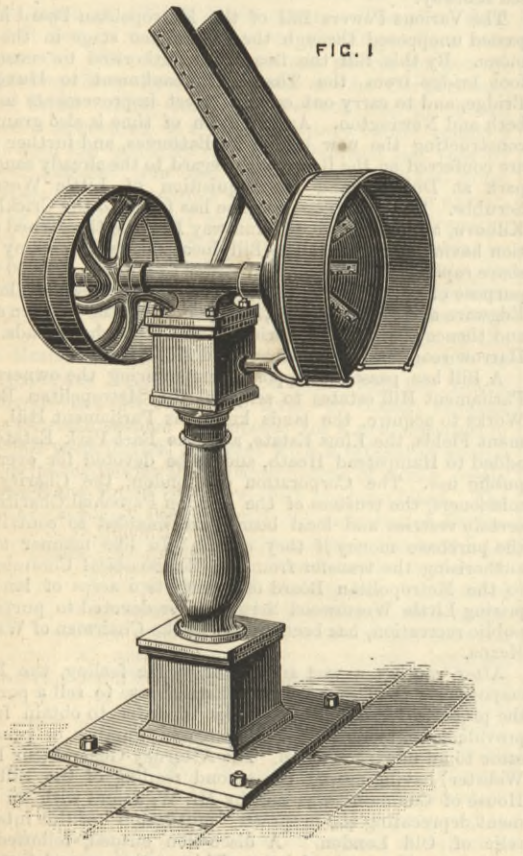
Yet another instance of good fortune to promoters. The Select Committee of the House of Lords, presided over by the Earl of Belmore, having refused to allow a *locus standi* to either of the opponents of the Bill promoted by the Hull, Barnsley, and West Riding Railway, this measure has passed as an unopposed Bill through their lordships' House. By this Bill the Hull and Barnsley Railway Company is authorised to abandon a portion of the railway in the neighbourhood of Kingston-upon-Hull, sanctioned in 1883, owing to the company having been, as stated in the preamble, "unable to raise the necessary funds for the construction of the works." The Bill, however, gives powers to the company to raise six per cent. preference stock to such a nominal amount as shall be sufficient to produce £500,000 at the price at which the same shall be issued. The dividends to be payable on this stock are made cumulative for the first seven years. A clause in the Bill extinguishes all powers to raise any capital or debenture stock authorised by the Act of 1883, which capital, together with that sanctioned in 1882, the preamble states, the company "has been unable to raise."

THE MANUFACTURE OF SOAP.

THE first manufacturer of soap lived in prehistoric times, before the age of bronze or of worked stone, and possibly before the advent of man upon the earth, for the first sheep was a maker of potash soap. The experiments of Maumené and Rogelet prove that a fleece weighing 9 lb. contains about 7 oz. of pure potash, of which they consider nearly 6 oz. to be recoverable, although it is at present often wasted. This potash on the sheep's exterior mixing with a portion of the greasy matter of the skin produces a certain amount of soap, consequently by washing a sheep with a limited quantity of pure water it is possible to get up a lather. Thus the agricultural labourer of the future, advanced in scientific education, may, in washing the faces of his proverbially numerous children, utilise the pet lamb of the family as a large sponge charged with soap.

The Hebrew word *borith*, used by Jeremiah, and translated "sope," refers to potash lye; and the word *nether*, translated "fuller's sope," refers to mineral lye, or soda. Pliny and Galen are the earliest secular writers who speak of soap; Pliny says that it was made by the Germans and the Gauls, that it was sometimes hard and sometimes soft, and that it was made of goat's fat and the ashes of the beech tree. Galen says that it was made of the tallows of the ox, sheep, and goat, strengthened with lime. In those early times it appears that soap was not used for washing purposes, but to dye and beautify the hair, also as a medicine; sometimes it was made as required for use, ashes and oil being rubbed over the head; thus it is possible that the ancient sayings about anointing the head with oil and casting ashes upon the head, may, contrary to the general impression, have had reference to a process of beatification by saponification. Geber, in the second century, speaks of soap, and Arab writers mention that it was used for cleansing purposes, also as an ointment. Strabo states that in his day alkaline water was employed by the Armenians for washing clothes. The ancients also used saponaceous plants, as well as seeds, bran, and fuller's earth for washing purposes. Much water was not always considered essential in these cleansing operations, white or coloured earths being often rubbed into the

FIG. I



SOAP SHREDDING MACHINE.

fabric to give it a bright uniform appearance, just as our soldiers now use pipeclay, and as glovers sometimes improve the appearance of leather.

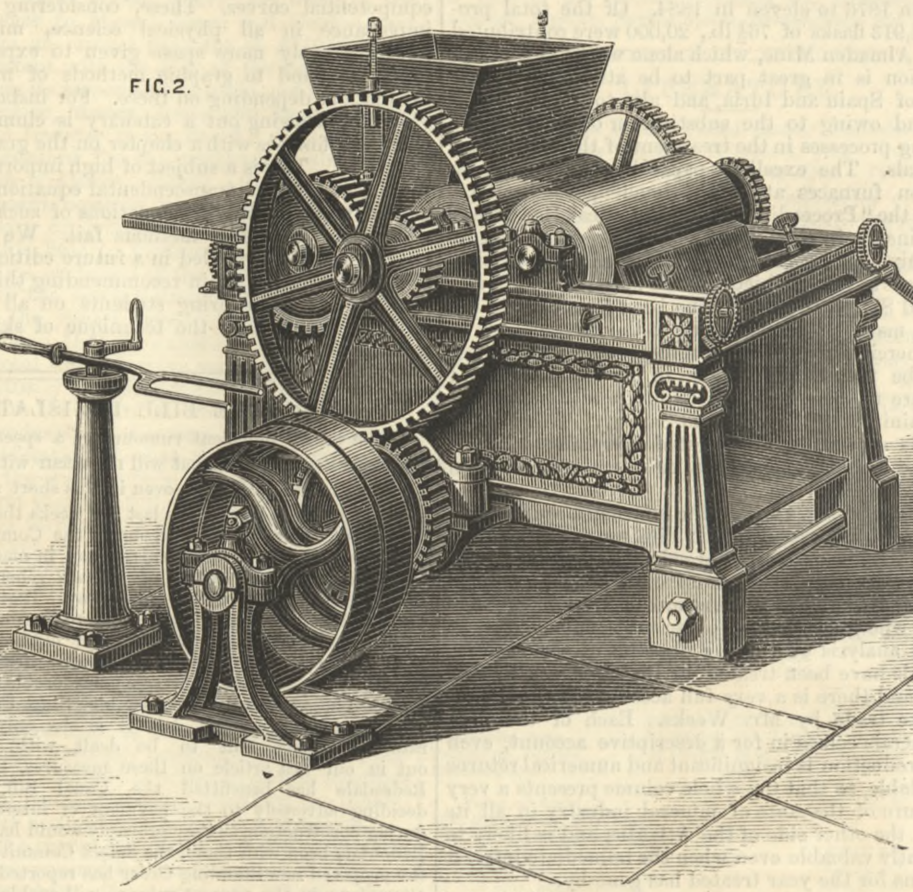
In more modern times France was for a long time in the van in the manufacture of soap, that of Marseilles being celebrated all over Europe, and holding a front rank to the present day. The soap manufacture of England was once retarded by heavy taxation, and by the presence of excise officers in the factories, so that the makers, knowing that any improvement they might make was liable possibly to be communicated to their competitors by persons over whom they had no control, had small temptation to try novel processes. The soap duty was not repealed until 1853; in the beginning of that year the duty on soft soap was a penny a pound, and upon hard soap three-halfpence. As there was then no duty upon soap in Ireland, smuggling of soap between England and Ireland was common.

Soap is made by boiling tallows or oils with one or other of the fixed alkalies, potash and soda; potash produces soft soaps and soda hard soaps. Ammonia is slow in acting upon oils and fats; the union can be effected with time and difficulty, but the products have no special application, and are not manufactured commercially.

The practical applications of the brilliant series of discoveries made by Chevreul early in the present century, on the chemistry of the fatty acids, are now carried on on a large scale in the various works of Messrs. J. C. and J. Field, two of whose establishments have already been described in these pages. Messrs. Field have works for the making of soap for manufacturers connected with various trades, at Bermondsey New-road, London. To these works the oleic acid freed in the manufacture of stearine candles is sent to be saponified; cottonseed, olive, and other oils are there also made into soap. The great thing to be done with cottonseed oil is to get rid of it; some is made into soap; some goes from the cotton-spinning districts to Italy, to come back as olive oil; much goes to lubricate the familiar sardine, less tightly packed in his tin box with his friends, than an Icelandic family by night in their hut—at least so says Dr. Leitner, who asserts that in a well-regulated sardine box all the inhabitants can lie at full length, but in an Icelandic hut by night, the dwellers, though equally tightly packed, are doubled up. Good cottonseed oil is, at any rate, better than inferior qualities of olive oil as an article of food.

The oleic acid from the Lambeth candle works reaches the Bermondsey works in casks; the bung of the cask is removed, the pipe of a pump is inserted, and the liquid pumped into an iron spout, down which it runs into the vessel in which it is to be boiled, which is made of iron, but called by the workmen "the copper." At the same time a warm solution of caustic soda is pumped from the floor below into the same spout; the oil and alkali mix in the spout, then fall well mixed into the copper. The alkali used is caustic soda, which arrives at the works in a solid state in iron drums, having been poured therein at a great heat at the alkali works. Caustic solid soda exerts no chemical action upon bright iron. Each drum contains a solid cylindrical lump of soda weighing 5 cwt. Several of these huge lumps are placed in a large iron vat, water is added, and the whole left for about forty-eight hours, for after the water

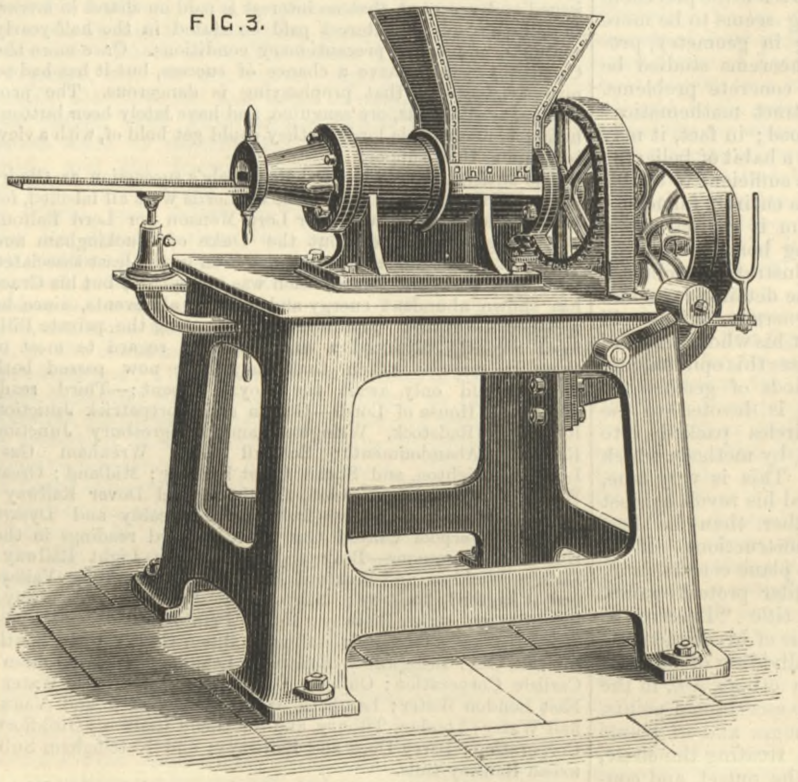
FIG. 2.



SOAP MILLING MACHINE.

has taken up a certain amount of soda the remainder of the mass is but slowly soluble. When the solution commences overnight, the heat which is generated by the act of solution is at its maximum next day; in fact, the warmth of the soda lye when it is first mixed with the oil in the spout is due to the hydration, and not any external application of heat. Additional heat is generated by the more complete union of the alkali with the acid oil in the copper, a maximum of over 200 deg. Fah. being thus reached, if necessary, without the application of any fire at all. There are five coppers at the

FIG. 3.



SOAP PRESSING MACHINE.

works, each holding five tons of lye and five tons of oil. The ten tons of liquid in the coppers are boiled for about twenty-four hours, then the mixture is allowed to cool; the spent lye is next run off, and fresh caustic of different strength added. In the boiling a scum, consisting chiefly of imperfect soap charged with minute air bubbles, forms at the surface of the mixture; this is skimmed off and boiled down with the next make of soap. The treating of oils with alkaline lyes is termed "salting," and as oils vary, the salting is performed again and again until an approximately neutral stage is reached; when neutral the soap is tasteless when the tongue is applied to it. A small surplus of alkali, such as is usually present, gives soap the well known strong alkaline taste. The strength of the lye used is one part of soda to six parts of water in the first boiling; in subsequent boilings the strength of the lye is considerably greater. One part of oleic acid soap usually contains sixty-eight parts oil, seven parts soda, and twenty-five parts water. Olive oil soap is at first green; afterwards it turns yellow, more especially where exposed to the air and in parts adjacent thereto; this is probably due to the evaporation of water. The cost of the caustic soda used is about £10 a ton; its chief impurities are sulphate and carbonate of soda, varying from 8 to 12 per cent.

When the saponification is complete, the soap is disseminated in the spent lye as a mass of globules, which have to be boiled briskly until they coalesce. Strong lye is then added which "throws out" the soap insoluble in that medium. The copper is then left to cool down, after which the soap is ladled into large built-up rectangular wooden or iron moulds, within which the soap solidifies, but is stirred occasionally with a kind of a wooden crutch to make it homogeneous throughout, hence the mixing of soap is technically called "crutching," and varieties of apparatus for mixing it go by the name of "crutching machines." When the soap has hardened in the mould, the sides thereof are unscrewed and removed from time to time from the top downwards, leaving the block of solid soap exposed and ready to be cut into bars by wires.

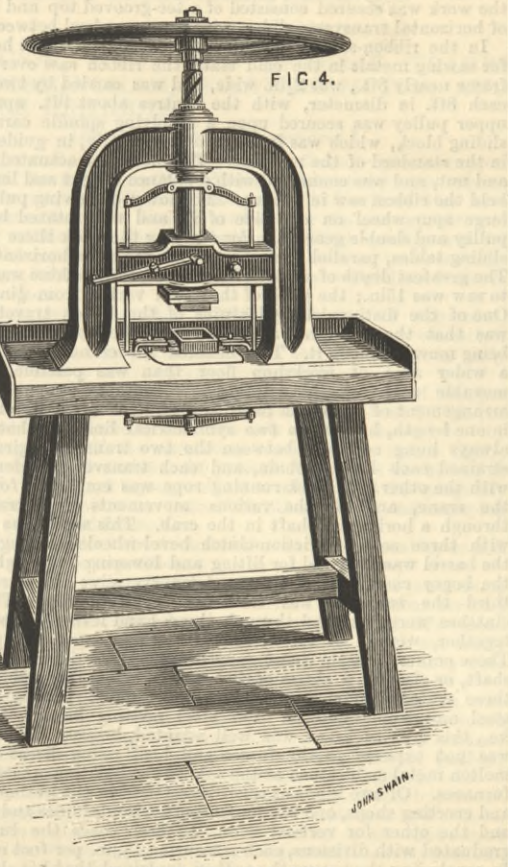
The soaps made at Messrs. Fields' Bermondsey Works have long been known to dyers and cleaners under the name of "pure oil soap." While all other soaps are mixtures of stearates, palmitates, oleates, and resinates of soda in various proportions, the soap above described is almost pure oleate of soda, the interest of the makers, in view of the far higher price of the solid stearic acid, leading them to extract it as thoroughly as possible from the cheaper oleic acid. This is accomplished by freezing and cold pressing, processes which inventors of late years have carried to great perfection. The saponified oil produced from the lime process described in our article on candle-making is finer than the oil yielded by distillation, inasmuch as the latter process tends to break up the oxy-acids into unsaponifiable hydrocarbons. The presence of the latter in an oil soap becomes apparent on dissolving it in water. If pure, the solution is perfectly transparent and bright; if hydrocarbons be present, the liquid is opalescent and murky. As hydrocarbons are quite insoluble, dyers and spinners dislike them by reason of their permeating the fibre under treatment and permanently dimming the same. It will be evident to anyone who has followed the details of the process of making pure oleic acid soap that it must be far more alkaline than such soaps as are "cut" with salt liquor, which washes out the excess of soda. This preponderance of alkali is no detriment in the eyes of the consumers, who find it serviceable in cleaning the somewhat intractable materials of their trade; indeed, some will not look at a soap which is not incrusted with the carbonated alkali; it is a guarantee to them that no unsaponified fat is present, for such fat would be bad for their purposes. For delicate colours, especially of aniline origin, pure oil soap is unsuited, as the free alkali instantly takes the acid from the brilliant salt, leaving the colourless base. Messrs. Fields, however, are engaged in experiments which promise shortly to give the world a chemically neutral soap.

The toilet soaps of Messrs. Fields, the manufacture of which we are now about to describe, are not made at Bermondsey, having nothing in common with the class of soap there produced. The machinery is fitted up in a part of the Ozokerit Works, at Battersea. The chief of the many products of the Battersea Soapworks is the so-called "Samphire Soap," but samphire enters as little into the composition of its godchild as honey or Windsor into their respective synonyms. The name has been selected as that of the best known sea plant, and typifying sea air and water, the qualities of which are condensed in the soap of that ilk. The body of this soap consists of olive oil which has been saponified with potash obtained from burnt seaside plants, and afterwards "cut" with salt, thus forming a soda soap, with sufficient potash to impart softness and mildness to the otherwise hard and insoluble soda compound. This is melted in a special steam pan, with palm oil and other refined soaps. When thoroughly liquid the mass is subjected to a process which neutralises the free alkali present in all crude soaps; this result is further assured by the addition of several vegetable acids, such as thymic and salicylic, and a proportion of iodised and brominated eucalyptol. About 20 per cent pure glycerine is finally worked in, and the whole stirred for several hours at the highest possible temperature. The soap is then allowed to cool a couple of days in iron frames holding about 3 cwt. each. When cold the block is cut into slabs, and then into bars, which in their turn are finely shredded in a machine to be hereinafter described. These shreds are first dried on wire netting, in a hot-air chamber at 200 deg. Fah. for twenty-four hours, during which time they lose 25 per cent. of their initial moisture, retaining about 2 or 3 per cent. held by the glycerine. The chips are now passed through the mill—*v. infra*—four or five times, till perfectly homogeneous, and thence removed, now as long strips greatly resembling seaweed, to the plotter, or screw-press, whence the soap issues as a long bar, exceedingly hard and of a deep green tint. This is cut, while still warm from the pressure of the screw, into cakes suitable for stamping, which operation is not performed before they are a week old, and capable of rendering the engraver's work in sharp completeness of outline. Thus the completion of the process in which the crude oil attains to fulness of completion as saleable soap occupies nearly a fortnight.

The above description applies to all soaps treated in this manner, that is to say, milled soaps, with the exception of the base soap, and the colouring and scenting. Samphire soap has no artificial colour and scent, but the public eye and nose demand these adjuncts, and the populace sometimes obtain them at the expense of their skins. The colour, generally a solution of some aniline or anthracene compound, and the scent, which may perhaps be cassia, citronelle, cloves, or storax, are sprinkled on the chips while in the hopper of the mill, the action of which is quite sufficient to thoroughly incorporate them with the soap.

The milling and plotting portions of the above process were

FIG. 4.



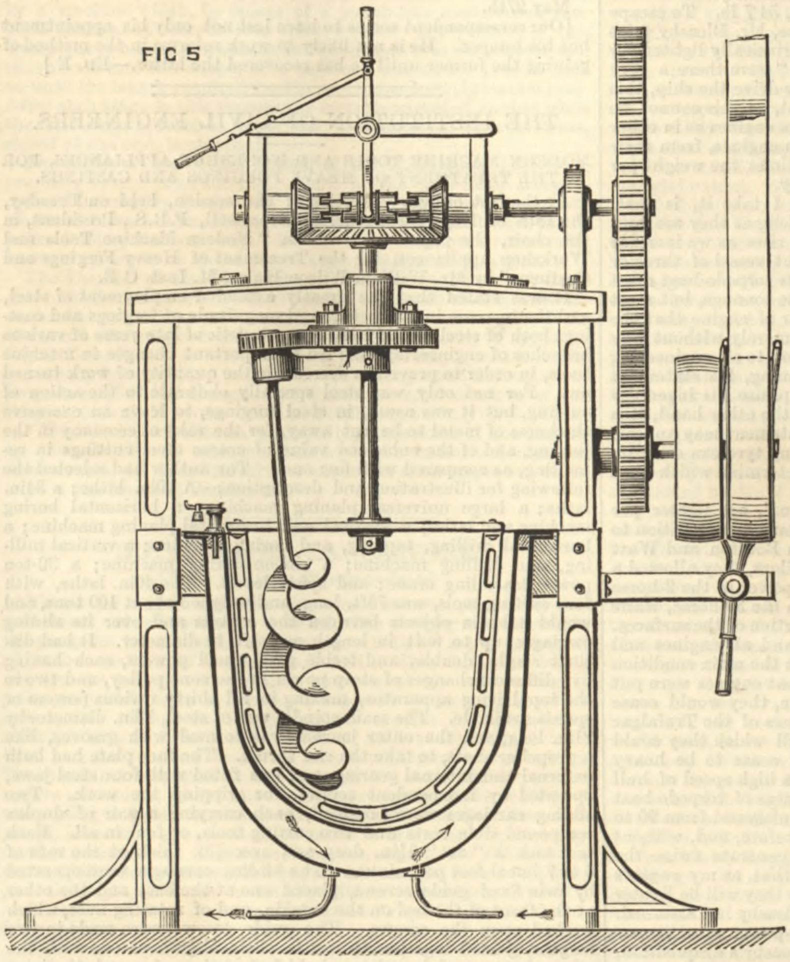
SOAP STAMPING MACHINE.

perfectly and thoroughly shown by Messrs. Cleaver, at the Health Exhibition at South Kensington, in 1884, and some of our readers perhaps remember the ingenious stamping appliance, with its mechanical fingers for removing the embossed cake from the mould. It would not be remunerative, however, to make the common soaps, such as are sold retail at 6d. a pound, by this method. A certain class also, known as Windsors, lose some of their characteristic qualities when milled; for their manufacture the crutching machine is employed, with the addition of pearlash or carbonate of potash. Thus, at Messrs. Fields', the well-known United Service soap—a typical brown Windsor—is made as follows:—Scraps and cuttings from previous boils, and from all the finer toilet soaps turned out at the factory, are melted down with a proportion of palm oil, or skin soap and Cook's primrose. The mixture is thoroughly crutched, framed, cooled, stripped, shredded, and again melted. By this double melting the soap is very thoroughly united or welded, and acquires emollient qualities. A strong solution of pearlash being now stirred in, in about the proportion of one pound to each hundredweight of soap, the paste, which heretofore was dark and transparent, becomes light yellow and opaque, much resembling butter in appearance and consistency. The philosophy of this action of the pearlash is at present unknown. Of the marked nature of the change there is no doubt; possibly an interchange between the potash and soda takes place, or double oleates of potash and soda are formed. Who knows? At any rate, it is not possible to make a good re-melted toilet soap in this manner without pearlash, although that compound is undesirable because of its tendency to throw out or incrust the soap, thereby spoiling both the appearance and the sale. There is no doubt, also, that the extra alkali must act injuriously on delicate skins, to a considerably less extent, though, than is sometimes asserted. After the pearlash has done its work the scent is added, which, in the case of the United Service soap and Brown Windsors generally, consists of vegetable gums and balsams, with civet, ambergris, and so on, according to the taste and opulence of the manufacturer. The mass is then framed and caked as before.

The soapmaking machines used at Battersea were constructed by Messrs. Morane and Co., Rue du Banquier, Paris. The soap-cutter, or slicer, represented by Fig. 1, makes about 100 revolutions per minute, and is fed with bars of soap by means of a wooden guide placed at an angle to the cutter. The disc on which the cutters are mounted is slightly conical, and about 12in. in diameter across the face. The cutters are usually four in number, and are fixed radially from the centre of the disc, performing their cutting operations in much the same fashion as an ordinary spoke-shave. The slices cut are thin and wet; care has to be taken not to shave them too finely, or they would so cling together in the wooden receptacle below the slicer as to form an almost homogeneous mass, and thus defeat the object of effecting division. Next the chips are spread upon cloths, and placed upon the wire netting in the drying cupboard until they are dry and brittle.

Fig. 2 represents the granite rolling mill. It consists of three granite rollers, each about 2ft. long and 12in. in diameter, supported on a strong iron framework; the rollers, as already stated, rotate at different speeds relatively to one another. The spur gearing by which this is effected is so arranged as to give the first roller about 20, the second 32, and the third 48 revolutions per minute. The driving of the rollers themselves, added to the milling they have to perform, is heavy work, and absorbs much power. The rollers revolve in adjustable bearings to regulate the thickness of the milling; as a rule they nearly touch each other; the first and second are slightly farther apart, if anything, than the second and the third. Rollers one and three move from left to right, and the central roller in an opposite direction. The soap chips from the hopper pass between the first two rollers, forming a thin film on the under surface of the second roller; this film is further reduced in thickness by the pressure between rollers two and three.

FIG 5



SOAP MIXING MACHINE.

Clamped against the outer edge of the third roller is an iron comb, with teeth about ⅜in. wide and the same distance apart, which divides the coating of soap, and throws it off in the form of narrow ribbons, which are caught by a wooden receptacle. The remaining coating on the roller is removed, and the roller entirely cleared from soap by means of a scraper clamped with its edge against the roller, and immediately beneath the comb.

Fig. 3 represents the bar-shaping or "plotting" machine, in which the ribbons from the milling machine are pressed into bars. In the interior of the cylinder is a spiral conical screw, with its threads in close contact with the surrounding casting; this screw is driven by gearing at a speed of about twenty revolutions per minute. The screw tapers from about 12in. in diameter at the feeding end to about 6in. at the ejecting end; the thread has seven turns in an entire length of about 15in. Our engraving represents one of Messrs. Morane's machines with an ordinary, not a tapering cylinder, but the machines are made in both forms, and Messrs. Field prefer those which taper. On the ejecting end is screwed a removable disc, perforated as closely as possible with small holes about ½in. in diameter, through which the soap is pressed after being fed along the spiral conical screw. Over this disc is screwed a nozzle, at the extremity of which is the aperture through which the soap is ultimately passed; a small place is left for compression between the perforated disc and the exit opening. In this space the cylinders of soap forced through the perforated disc are squeezed together, and as the cylinders meet the pressure naturally forces them into hexagonal form, or the shape of the cell of the bee; cellulose cells seem to be naturally round, as in soft fruits like the strawberry; the hexagonal forms they take in parts of the shoots of the elder tree may be due to the same forces which produce the same forms in Messrs. Field's soap machine. The exit nozzle can be of any desired shape to give the desired form to the bar of soap.

Fig. 4 represents the soap-stamping machine, in which blocks cut from the bars are stamped and lettered. Messrs. Field prefer a machine with a lever, rather than with a horizontal wheel, to apply the necessary force. Two rods attached to the stamping spindle pass down through the table of the stamping machine, and the cross-piece which unites them beneath carries in its centre an upwardly projecting rod, which, under the control of a spring, serves, on the return of the upper die to its normal position, to loosen and nearly eject the soap tablet, the lower die being then ready to receive another block.

Fig. 5 represents one of the soap mixing machines in use at the Battersea works. In the trade it is known as a "soap crutching" machine, no doubt in consequence of the primitive way of mixing soap having been by stirring it with an instrument resembling an inverted crutch, which instrument is still used at the Bermondsey works, to stir finished soap while it is hardening into massive blocks. The Battersea machines were made by R. Houchin and Co., and consist of a steam jacketted iron vessel of about 2½ft. in diameter and 2½ft. in depth, containing when full about 3½ cwt. of soap. The machine is set in motion by shifting the driving band from a loose to a fixed pulley, the axis of which carries slow speed gearing; the lowest wheel of the gearing has a shaft which passes loosely between two small bevelled cog-wheels facing one another, both with a circular clutch on their inside faces. Between these two clutches, and mounted on the shaft, is a double-ended clutch which revolves with the gearing, but is capable of being guided along the shaft by means of a hand lever loosely fitting it, so as to work into either one or other of the bevelled cog-wheel clutches, and thus, since both the latter gear into a larger bevel wheel at right angles to them, effect the forward movement or reversal of the stirrer, which is carried by a spindle descending from the larger bevel wheel. Passing through a bearing in the centre of the crosspiece of the machine, and through a stationary cog-wheel bolted thereto, the spindle terminates in a light cross-piece bearing the perforated U-frame, to one edge of which is fitted a scraper, which is in close contact with the pan during the entire revolution, and prevents any soap from sticking to it, the other edge of the scraper being a couple of inches away from the pan, and assisting to stir the soapy emulsion. When the pan is full the frame is driven at about 15 revolutions per minute; the spiral-bladed twister travels the same number of times round the pan and makes 60 revolutions on its own axis. The twister receives its motion from an arm fixed on the spindle holding the U-frame; this arm ends in a bearing, above which, and gearing at a slight angle into the aforementioned stationary cog-wheel, is a small spur wheel, on the end of whose spindle is the spiral twister. Both the internal and external pans are of iron; steam at low pressure circulates between the two to keep the soapy emulsion at a temperature of about 200 deg. Fah.; any excess of pressure is relieved by a small safety valve.

Chevreul, whose brilliant discoveries in relation to the chemistry of the fatty acids, did so much to establish the soap and candle-making industries upon a scientific basis, is still living, and towards the close of this year will be one hundred years of age, when some kind of international centenary celebration is contemplated to be held in his honour. Michael Eugene Chevreul was born at Angers in 1786, and studied in Paris under Vauquelin. He became director of the dye works and professor of special chemistry at the Gobelins, where he studied the laws of the influence of adjacent colours upon the appearance of each other. The results of his researches were published with coloured illustrations, and well deserve the perusal of those manufacturers who desire to produce the most pleasing effects with associated colours. His first scientific memoir was written so long ago as 1814-15. His discoveries in relation to the chemistry of the fatty acids were very complete; he was the discoverer of oleic acid, the basis of the fat oil soaps, a substance which although so largely used in the crude form, can be prepared in the pure state only by troublesome chemical operations. It can be obtained from the fat of man or the fat of the goose, as well as from that of the ox, sheep, pig, and some other animals; it is present in animal fats but in small proportion, but is plentiful in the non-drying vegetable oils. To obtain it pure, oil of almonds is saponified, the crude soap is decomposed by an acid, and the resulting oily acid is digested in a water bath for several hours with half its weight of oxide of lead; the mixture is then agitated with twice its volume of ether, and left for twenty-four hours, after which the clear solution is mixed with diluted hydrochloric acid, when the oleic acid rises to the surface dissolved in ether. The ether is removed by gentle evaporation, and the oleic acid again saponified by soda. It is then further purified by chemical means, and afterwards by occasionally crystallising it by cold at a temperature of about 20 deg. Fah., and separating the more impure portions by the aid of blotting paper. It is afterwards crystallised from alcohol, and dried in a current of carbonic acid gas, for pure oleic acid absorbs oxygen somewhat freely. The pure acid is, at temperatures above 57 deg Fah., a perfectly clear, colourless, oily liquid, without smell or taste. It does not redden litmus. It solidifies at 39 deg. Fah. or 40 deg. Fah., and below 39 deg. Fah. it is very hard. It is insoluble in water, soluble in alcohol and ether, and miscible with oils and fats; by absorption of oxygen it turns brownish yellow, and acquires a rancid smell. As an acid it is monobasic.

SOCIETY OF ARTS CONVERSAZIONE.—One of the two Fridays for which the right of excluding the public has been reserved by the Royal Commission for the Colonial and Indian Exhibition has been allotted to the Society of Arts for their Annual Conversazione, which will be given at the Exhibition on Friday, the 16th of July. Arrangements have been made for the purchase, by members of the Society only, of tickets to the fête, on the same system as that which proved so successful last year. Members, who will receive the usual invitation for themselves and a lady, will thus also be enabled to obtain tickets for other members of the family. The price of the tickets has been calculated so as just to cover the actual cost of the entertainment, and to leave sufficient margin to repay the Royal Commission for the loss resulting from closing the Exhibition for the evening.

ENGINEERING SOCIETY, KING'S COLLEGE, LONDON.—At a general meeting, held on Tuesday, May 18th, the president in the chair, Mr. V. J. Boutar read a paper on "Steam Boilers." The first part of the paper was devoted to the consideration of combustion in its practical aspects and to the prevention of smoke. The author here pointed out the impossibility of obtaining the theoretical evaporation with a given amount of fuel; next, the dangers of priming, corrosion, incrustations, and explosion were described, with the means of preventing them or counteracting their effects. The second division of the paper was then begun, its subject being the materials used in boiler construction, the defects of rivetted joints were explained, and the superiority of welding over rivetting was proved by reference to various carefully conducted experiments. The construction of furnaces, flues, and tubes was then dealt with, especial attention being paid to Fox's corrugated furnaces and flues. The paper ended with descriptions of several typical forms of boilers, including among others the Whittle, Bone, and Galloway stationary boilers, Dunn's marine boilers, and the ordinary English locomotive boilers.

LETTERS TO THE EDITOR.

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

FORTY-KNOT-SPEED SHIPS.

SIR,—I am glad that you have given insertion to Mr. Bleasby's letter challenging the accuracy of my determination of the speed obtainable in large vessels of the torpedo-boat type, with a given power of engine. The subject is obviously one of commanding importance to the interests of this maritime country. Letters which I have received show that the discussion is already attracting attention in influential quarters, and the articulate defence of demonstrable error affords the fairest opportunity of effectually exposing its real character, and so accomplishing its extirpation.

The nature of my proposal to establish lines of light and swift ocean vessels, capable of performing voyages of 3000 miles at a speed of forty knots an hour, is already known in outline to your readers. Mr. Bleasby contends that the feat is impossible, and he bases his incredulity on the hypothesis that the weight of 60 lb. per indicated horse-power, which I have set down as an adequate weight for the machinery of such vessels, is wholly insufficient, and that such a weight must be introduced as would sink the vessel to the bottom, seeing that the weight per horse-power taken would require to be three times greater than that which I have assigned. Here, however, Mr. Bleasby is confronted by the fact that in various torpedo boats, and other light vessels, the weight of machinery per horse-power is even less than that which I provisionally adopted. Thus, in torpedo-boats of the first class the weight of the machinery per horse-power has been experimentally ascertained to be 57·7 lb. In the Miranda yacht it is 62·8 lb., and in the Gitana yacht 43·5 lb. —or on an average of all the examples cited, 54·7 lb. To escape from the confutation afforded by such evidence, Mr. Bleasby tries to make us believe that small engines are intrinsically lighter per horse-power than large, and that although, "were there a very large number of high-speed engines applied to drive the ship, this [weight of 60 lb.] might be sufficient," yet that, as this cannot be done, "we are obliged to have recourse to large engines as in other ships"—such as the war-ship Trafalgar, which engines, from their slowness and otherwise, are of about three times the weight per horse-power of those which I propose to employ.

The meaning of Mr. Bleasby's utterance, I take it, is that, although we may make very light engines so long as they are very small, the weight per horse-power necessarily rises as we increase the size, so that the engines proper for a light vessel of three or four times the lineal dimensions of a first-class torpedo-boat must not only be large and heavy in proportion to the tonnage, but must have three times the weight per horse-power of engine that the smaller boats require to have—a doctrine not merely without any species of justification, but in direct opposition to all engineering experience. If this be not Mr. Bleasby's meaning, his statement is a mere juggle of words, and I cannot praise his ingenuity except at the expense of his sincerity. If, on the other hand, it is his correct meaning, then, incredible as the statement may appear, he commits himself to an absurdity which any tyro can confute. It rests wholly with Mr. Bleasby himself to determine which horn of the dilemma he elects to embrace.

That large engines, other things being equal, are lighter per horse-power than small ones, is too elementary a proposition to require demonstration in your pages. When Boulton and Watt first settled the proportions of their wagon boilers, they allowed a heating surface of 15 square feet per horse-power in the 2-horse boiler, and 9·8 square feet per horse-power in the 30-horse, while the respective weights were nearly in the proportion of the surfaces. The engines followed much the same law, and all engines and boilers follow this law at the present day. But the main condition of lightness is speed. If a pair of torpedo-boat engines were put into a coal barge which they could hardly move, they would cease to be light engines, and, contrariwise, the engines of the Trafalgar or other languid leviathan, if placed in a hull which they could drive at three times the existing speed, would cease to be heavy engines. It is the high speed of piston which a high speed of hull permits that is the main cause of the lightness of torpedo-boat engines, and if the speed of a light vessel be quickened from 20 to 40 knots the pistons will run twice as fast as before, and, without any increase in the weight of engines, will generate twice the power. Under such conditions it is obvious that, as my engines will be faster than torpedo-boat engines, so also they will be lighter instead of being three times heavier, as Mr. Bleasby has assumed. The allowance of a weight of 60 lb. per horse-power must consequently be recognised as adequate, and Mr. Bleasby's disquisition, based upon the opposite hypothesis, becomes merely "so much leather and prunella."

It only remains that I should explain for Mr. Bleasby's benefit why Reech's law was adopted by me, to determine approximately the speed that would be produced by a given power, instead of the older method, according to which the resistance is measured by the immersed section. The reason was because it has been found that although up to such speeds as 10 knots torpedo-boats demean themselves similarly to large vessels, their conduct becomes quite different beyond that speed, especially when they begin to rise in the water and thus to alter their immersion. At first the resistance varies as the square of the speed, according to the law obtaining in larger vessels. Thereafter it rises to the 3·5th power, and further on falls to the 1·5th, and eventually to the 1st power, or to the resistance answering to the simple speed. At some such speed as 35 or 40 knots large and light vessels, it is believed, will comport themselves in precisely the same way as torpedo-boats do at 20 knots, so that their performance may be predicated by Reech's law. But this, though a highly probable supposition, has not yet been experimentally verified. It should further be explained that in all torpedo-boats the boiler has, for the sake of lightness, been overtaxed, and that where voyages of any considerable length have to be performed, it would be proper to alter this state of things by the use of more boiler power, which in its turn will somewhat increase the weight of the machinery per horse-power. But the change would, by diminishing the consumption, simultaneously reduce the weight of coal which would have to be carried by the vessel, and I have therefore allowed the figures to stand without rectification on either side, on the assumption that one weight would balance the other. It will be seen by a reference to former figures that the consumption of coal was taken at 2 lb. per horse-power per hour. Less than this would certainly be sufficient, and if we suppose that 1½ lb. per horse-power could be made to suffice, we should save over 400 tons of coal on every voyage of the larger vessel. This would much more than balance the increased weight of any larger boilers that it might be considered advantageous to employ.

The details of the proposed vessels I will give in a subsequent letter, should you consider that they would be of interest to your readers. C. F. HURST.

Student, College of Practical Engineering,
Chiswick, W., May 25th.

PUBLIC SURVEYORS.

SIR,—In advertising for surveyors the Metropolitan Board of Works and the various Vestry Boards of the metropolis generally stipulate that candidates must either hold certificates from the Institute of British Architects or must have passed some cramming examination held by one of the numerous sanitary institutes or societies of the day.

I have the doubtful honour of being an Assoc. M. Inst. C.E. By "doubtful" I mean that although that diploma was conferred on me in respect of nearly twenty years' experience in many branches of the profession, it goes for very little when compared with many other qualifications.

If there is any value whatever in the distinctions conferred by the Institute of Civil Engineers, I think it is high time that the authorities of that body looked after the legitimate interests of the members. Why should members of other societies or institutes have any advantage over theirs? Surely sufficient influence could be brought to bear upon at least the Metropolitan Boards.

It may perhaps be urged that the duties of public surveyors pertain more to the science of architecture than to its sister profession, but I do not believe so. Proficiency in the latter necessarily includes a general and sufficient knowledge of the former. Besides, the duties of a surveyor are varied and many, and more likely to be carried out efficiently by a practical engineer than by an architect whose triumphs (?) have been those of the office.

My object in writing this letter is chiefly to point out the difficulty that competent men of experience have in getting their claims recognised as candidates for public surveyorships. Pupils just emancipated from a few years' experience in the art of throwing india-rubber about; glorified bricklayers' apprentices, starting on their own account, with a few sheets of tracing paper and a second-hand "dumpy;" the son-in-law of the local builder and chairman of the Vestry Board—these are the sort of men who would defeat a Brunel or a Hawkesley in a competition before a Board of third-rate grocers and bakers, who pin their faith on some examination certificate not worth the paper it is written on as an evidence of practical experience.

In the interests of those younger members of the profession who may be really going through a careful course of training, and are duly qualified by circumstances of education and breeding, and even more by conscientious devotion to a noble calling, I trust that some able pen may take the matter up, and succeed in crushing the system that too often allows the expression "Town Surveyor" to represent to the mind of well-regulated iudividuals a personage chiefly remarkable for ignorance, incompetency, cheek, and doubtful sobriety. A DISAPPOINTED MAN.

May 27th.

[Our correspondent seems to have lost not only his appointment but his temper. He is not likely to work reforms in the method of gaining the former until he has recovered the latter.—ED. E.]

THE INSTITUTION OF CIVIL ENGINEERS.

MODERN MACHINE TOOLS AND WORKSHOP APPLIANCES, FOR THE TREATMENT OF HEAVY FORGINGS AND CASTINGS.

AT the last ordinary meeting of the session, held on Tuesday, the 18th of May, Sir Frederick Bramwell, F.R.S., President, in the chair, the paper read was on "Modern Machine Tools and Workshop Appliances, for the Treatment of Heavy Forgings and Castings," by Mr. William Wilson Hulse, M. Inst. C.E.

It was stated that the greatly extended employment of steel, and the increase in the weight and magnitude of forgings and castings both of steel and of iron, characteristic of late years of various branches of engineering, had led to important changes in machine tools, in order to prevent a decrease in the quantity of work turned out. For not only was steel specially obdurate to the action of cutting, but it was usual, in steel forgings, to leave an excessive thickness of metal to be cut away, for the sake of economy in the forging, and of the enhanced value of coarse steel cuttings in remelting, as compared with fine ones. The author had selected the following for illustration and description:—A 40in. lathe; a 34in. lathe; a large universal planing machine; a horizontal boring machine and lathe; a vertical and horizontal planing machine; a horizontal drilling, tapping, and boring machine; a vertical milling, and drilling machine; a ribbon-sawing machine; a 30-ton power travelling crane; and spirit levels. The 40in. lathe, with four cutting tools, was 75ft. long, and weighed about 100 tons, and would take in objects between the centres and over its sliding carriages, up to 60ft. in length and 5ft. in diameter. It had distinct single, double, and treble gear wheel powers, each having five different changes of strap power in the cone pulley, and two in the top driving apparatus, making in all thirty various powers or speeds available. The main spindle was of steel, 13in. diameter by 21in. long, and the outer journal was formed with grooves, like a propeller shaft, to take the end thrust. The face plate had both external and internal gearing, and was fitted with four steel jaws, operated by independent screws, for gripping the work. Two sliding carriages were provided, each carrying a pair of duplex compound slide rests and two cutting tools, or four in all. Each tool took a "cut" 1½in. deep and over ¼in. thick at the rate of 6 to 7 lineal feet per minute. The sliding carriages were operated by twin fixed guide screws, placed one at the back and the other at the front of the bed on the outside, and of rotating nuts, which worked upon the screws. The guide screws were made in two lengths, joined together to insure their alignment one with the other; but as each length was held fast at the outer end, the joint was not subjected to torsional stress. The complete independence with which each sliding carriage could be traversed in either direction was an important advantage resulting from the employment of stationary instead of rotating guide screws. The 34in. lathe, with eight cutting tools, had fixed guide screws inside the bed between its two outer girders, and each sliding carriage was connected with only one of them. The spindle was of similar construction, but of greater strength than in the 40in. lathe. The bed was in two lengths bolted together. The two front girders supported and guided the front sliding carriages and tools, and the two back girders those at the back of the lathe. Each sliding carriage carried one compound slide rest fitted with two top slides, holding one cutting tool each. The cutting tools might be actuated conjointly or independently. The length of the lathe was 45ft. 6in., and the weight about 80 tons; and it was specially designed for turning steel ingots or heavy steel forgings in the rough.

An illustration was given of the large planing machine, capable of planing 30ft. long, 11ft. wide, and 10ft. high. The bed was 40ft. long, made in two lengths. The table was 33ft. long, cast in one piece strongly ribbed underneath. The machine was arranged for planing objects lengthwise, or crosswise, or vertically as in slotting. The possession of these several functions rendered the machine capable of treating, at a single setting, heavy objects, which otherwise might require several removals to, and re-settings on, other machines. The table was reciprocated by means of a large steel screw and travelling nut, the screw being driven at one end of the machine. The screw, being of great length and weight, was supported between the end bearings by adjustable cylindrical rollers, placed at each side, at intervals of about 10ft. apart. The rollers dipped in oil, and carried up oil to the screw. The travelling nut was partly cut away, so as to allow it to pass by the supporting rollers without colliding. The V slide surfaces of the table and bed were inclined to an angle of only 15 deg., and for lubricating them a series of other cylindrical rollers, dipping in oil, and mounted upon axles parallel with the inclined surfaces of the V slides, were introduced. The mechanism for producing the cutting feed, when planing longitudinally, was actuated by adjustable stops secured to the table, which, as the table traversed to and fro, alternately propelled a rack backwards and forwards through a greater or less distance, according to the positions in which they were secured to the table, the arrangement being such that the feed screws remained stationary during the cutting traverse, and were rotated only during the backward or non-cutting traverse. The extent of the feed was regulated by the distance the rack was traversed, and by the number of turns it caused the spur wheel to make. By this means the "cut" might be varied by gradations of $\frac{1}{64}$in. up to 2in. broad. It was applied only during the backward traverse of the table.

The horizontal boring machine and lathe was designed mainly for boring and facing medium-sized engine cylinders. Fast and movable headstocks were provided as in a lathe. The main spindle was of steel, with its outer bearing formed with grooves, as in a propeller shaft, to take the end thrust. Between the two standards, and bolted to them both, was a horizontal slide bed, which carried the sliding carriage. The two standards had vertical T-grooves on their inner faces for receiving the bolts which secured the horizontal bed to them. The boring bars, with cutters, were held between the centres of the headstocks and rotated by the face plate and a driver, the object to be bored being fixed to the tee-grooved table. The machine was capable of boring engine cylinders up to 30in. in diameter, and of turning and surfacing work up to 48in. in diameter.

The combined vertical and horizontal planing machine weighed about 90 tons, and was capable of operating over a vertical plane 20ft. long by 15ft. high, and over a horizontal one 20ft. long by 3ft. wide. The cutting tool was fixed to a compound slide, which was traversed vertically by a guide screw. The vertical slide bed was secured to two carriages, which traversed upon two horizontal slide beds. The traverse along these beds was produced by means of two guide screws, rotated simultaneously from the driving apparatus, which, through a horizontal shaft and bevel gearing, also operated alternatively the vertical guide screw. There were three distinct automatic cutting feed actions, one for planing vertically lengthwise, another for planing horizontally lengthwise, and the third for planing vertically crosswise. The whole of the mechanism was operated from one driving apparatus, conveniently placed at one side of the machine. For some descriptions of work it was useful to fix on the bed a T-grooved table about 8ft. square, having compound rectilinear and circular slides, as in a slotting machine table, to enable circular and curved, as well as flat work, to be planed.

The universal horizontal drilling, tapping, and boring machine would operate over an area of 16ft. long by 10ft. high. There were two standards which could be traversed horizontally to and fro along a slide bed; each was provided with a spindle, mounted on a carriage, movable up and down the standard automatically. For drilling and boring, the spindle was provided with variable automatic feed and quick-hand actions, and, when tapping work, the automatic mechanism was put out of gear, the spindle being left free to slide inwards and outwards under the influence of the tap. The spindle carriages were furnished with platforms, on which the attendants stood, and were carried about.

In the combined vertical milling and drilling machine the main frame was of strong box form; the spindle projected 24in., and had a vertical movement of 18in. The spindle worked in two conical bearings within a hollow square slide, movable vertically through square guides formed in the body of the machine. The lower bearing was close to the head of the spindle, and a locking screw was provided for holding the square slide firmly in position at any desired point of the vertical adjustment. A separate self-acting continuous feeding mechanism was provided for drilling or boring, to be brought into play when required. The table on which the work was secured consisted of a tee-grooved top and two pairs of horizontal transverse slides, with a worm-wheel between them.

In the ribbon-sawing machine for sawing off ingot heads, and for sawing metals in the cold state, the ribbon saw overhung the frame nearly 8ft., was 2½in. wide, and was carried by two pulleys, each 8ft. in diameter, with the centres about 9ft. apart. The upper pulley was secured upon a revolving spindle carried by a sliding block, which was free to move vertically, in guides formed in the standard of the machine. The block was actuated by screw and nut, and was connected with a balance weight and lever which held the ribbon saw in tension. The lower or driving pulley had a large spur-wheel on one side of it, and was rotated by a cone pulley and double gearing. For carrying the work there were two sliding tables, parallel to each other on the same horizontal plane. The greatest depth of work through which the machine was adapted to saw was 15in.; the pitch of the teeth varied from ⅛in. to ¼in. One of the distinguishing features of the 30-ton traveller crane was that the crab was a fixture upon the traveller, instead of being movable along it. This enabled the crane to operate over a wider area of workshop floor than was possible with the movable crab usually employed. Another feature was the arrangement of the chain for lifting and lowering, which was all in one length, but led in two symmetrical lines, so that the load always hung centrally between the two transverse girders, and strained each line of chain, and each transverse girder, equally with the other. A quick-running rope was employed for driving the crane, and all the various movements were transmitted through a horizontal shaft in the crab. This shaft was provided with three sets of friction-clutch bevel-wheels; through one set the barrel was actuated for lifting and lowering; through another the bogey carriage was traversed transversely; and through the third the traveller was traversed longitudinally. The three clutches were operated through three hand levers, situated close together, worked by an attendant standing upon the platform. These cranes were in some cases arranged to be driven by a long shaft, or else by a steam engine carried upon the crab, either of these systems being preferable to the quick-running rope for steel and iron foundries. For steel melting houses, foundries, &c., this type of crane was well adapted, because the attendant was not exposed to the fumes and heat rising direct from the molten metal as he stood at the side of the building opposite to the furnaces. Of two kinds of spirit-levels used in the author's fitting and erecting shops, one was for testing horizontal lines and surfaces, and the other for vertical ones. In both cases the tubes were graduated with divisions, each measuring $\frac{1}{250}$in. per foot of length. In concluding the paper, the author explained that his object had been, not to give an exhaustive account of the subject treated, but rather to make prominent such portions of it as appeared of chief importance.

THE GAS INSTITUTE.—The twenty-third annual general meeting of the members will be held on Tuesday, Wednesday, Thursday, and Friday, the 8th, 9th, 10th, and 11th June, 1886, at the Institution of Civil Engineers, 25, Great George-street, Westminster. Mr. Denny Lane, M.A., President, will occupy the chair. On Tuesday, June 8th, the chair will be taken at 10.30 a.m. Inaugural address by the president; presentation of the Birmingham medal and premiums; reading of papers and communications. The meeting will adjourn at 2 o'clock. Wednesday, June 9th, the chair will be taken at 10.30 a.m. The reading of papers and communications continued. Adjourn at 2 o'clock, to permit of visiting the Indian and Colonial Exhibition. Thursday, June 10th, the chair will be taken at 10.30 a.m. The reading of papers and communications, and the transaction of other business; election of new members and officers for the ensuing year, &c. The meeting will then be made special, in order to elect a trustee. Friday, Jnne 11th, visit to Woburn Abbey. Members will meet at Euston railway station at 10.25 a.m., and proceed by special train to Ridgmont, where vehicles will be in attendance to take them to the Experimental Farm of the Agricultural Society. From thence, by the kind permission of the Duke of Bedford, they will visit the Park Farm, and subsequently be conveyed to the spot where luncheon will be served. After luncheon, an inspection of Woburn Abbey and grounds will take place. The return journey will be made from Woburn Sands at 5.40, the arrival in London being expected at about 7.15. Price of tickets, including luncheon and conveyances, but not including wine, 11s. each. No tickets will be sold after 2 o'clock on Wednesday, June 9th. The following papers and communications will be submitted to the meeting:—"Statistical Information in reference to the Manufacture of Gas," by R. H. Jones, Beckenham; "The Utilisation of Residual Products in Gasworks," by J. T. Lewis, Wellingborough; "Claus' Ammonia Process of Purification," by C. Hunt, Birmingham; "A recent Experience in Purification by Oxide of Iron," by T. Travers, Cork; "On the Application of Tar and Breeze to Retort Furnace Firing," by W. R. Jones, Rome; "A New Departure in Water Heating," by T. Fletcher, Warrington; "The Relative Calorific Values of Tar—with and without steam—and Coke for Retort Firing," by F. G. Dexter, Wormwood Scrubbs; "The Economical Construction of Gas Holders," by J. Somerville, London; "Are so-called Elaborate Regenerative Retort Furnaces a Failure?" by R. O. Paterson, Cheltenham; "To what extent is it advisable for Gas Companies to work up their own Residuals," by J. Chamberlain, Beckton. Annual general meeting of the donors and subscribers to the Benevolent Fund, Thursday, June 10th.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, May 15th.

BROKERS representing iron and steel-making interests in New York and Pennsylvania are quietly awaiting the expected resumption of activity throughout the country that is believed will grow out of the settlement of labour troubles everywhere. A number of requirements have been heard of, and in some cases specifications for large quantities of iron and steel have been submitted, though it is not the intention of purchasing agents to close contracts much before June 15th, if so early. The latter half of the year will be a very active one in railroad building, iron-making, bridge building, and car and locomotive building. During the past year over 100 schooners were destroyed, and so far only about ten have been built to take their place. Shipbuilders are now in negotiation for a large amount of tonnage to replace that destroyed, as well as to provide increasing tonnage facilities for the Atlantic and Gulf coasts. The plate mills throughout Pennsylvania have recently received orders for several thousand tons of material, sufficient to keep them running up to midsummer at latest, and builders of bridges are now submitting specifications for material for several bridges across the Ohio, Mississippi, and Missouri, which will be undertaken this year. Prices everywhere are rather weak in small lots, but manufacturers believe a reaction will set in, and are therefore declining to take large orders at any shading. The nail strike continues throughout the West. The bituminous strike is holding 20,000 men in idleness in Pennsylvania and Maryland, and the 40,000 anthracite miners are waiting for an advance in coal before insisting upon a 10 per cent. advance in wages. Throughout New England a slight improvement in business is developing, and manufacturers in all branches are preparing for an active fall trade. Car and locomotive builders have been booking orders since the first of the month, which were held back during April, and the opinion is expressed by good authorities that the summer orders will be far in excess of last year. Labour troubles have been mostly settled on a basis of nine hours, benefitting about half a million workers.

Mr. James Black, representing a syndicate of British capitalists, was in Baltimore on Thursday with letters from the Manchester Chamber of Commerce and the Glasgow Association of Underwriters, representing a syndicate, which proposes to build the Chesapeake and Delaware Canal, at a cost of 8,000,000 dols., provided the citizens of Maryland subscribe 1,000,000 dols.

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

(*From our own Correspondent.*)

EXPORT demands for finished iron are not finding vigorous expression. Still the trade may be said to be of about the same volume as in the corresponding period last year. A few firms who have a good connection with Australia and other distant markets are receiving satisfactory lines for bars of medium quality and for sheets and hoops. The Indian and South American trade is under the average, but the United States demand is not without features of improvement.

The home trade does not exhibit much sign of expansion, and so far this year it has been of a disappointing character. Buyers continue to restrict themselves to the satisfaction of early necessities.

The effect upon unmarked iron of the late reduction of 10s. per ton in marked bars has been to weaken prices about 2s. 6d. per ton. In sheets, however, this effect is counterbalanced by the smaller supplies. If the restriction continues, as seems likely, sheet prices should revive. At present 20 gauge is to be had at £5 17s. 6d. upwards, 24 gauge at £6 to £6 5s., and 27 gauge £7. Best working-up sheets are quoted £9 10s. upwards, and stamping sheets £1 per ton additional.

Prices of galvanised sheets are weaker at the moment by reason of increased local competition.

Angle iron and girder plates are finding rather more purchasers. Chain and cable iron is in limited request. Quotations for best bars are maintained pretty firmly on the new basis of £7. Good merchant bars are quoted at £5 5s., but common sorts are freely offered at £5 level, and buyers reported this week that they were sometimes buying at £4 15s.

The competition of Lancashire and Northern ironmasters, who are more favourably situated for getting to the ports than South Staffordshire, continues severe, and with those buyers at a distance with whom price is the first consideration, irrespective of quality, Staffordshire makers find themselves greatly handicapped.

Bessemer steel is still offered at easy rates. Local buyers are getting supplies from Welsh works at—for blooms and billets, £4 15s. delivered, and plating bars £4 17s. 6d. to £5. Mild steel bars rolled in Welsh works are offered this week, delivered in Birmingham, of ordinary sizes, at £5 15s. per ton. Large rounds and squares, of 3$\frac{1}{8}$in. to 3$\frac{1}{2}$in., are £6 5s.; 3$\frac{5}{8}$in to 4in., £6 15s.; and 4$\frac{1}{4}$in. to 4$\frac{1}{2}$in., £7 5s. Small rounds and squares of $\frac{1}{2}$in. are £6; $\frac{7}{16}$in., £6 15s.; and $\frac{3}{8}$in., £7 5s. Small flats, 1$\frac{1}{8}$in. to 4in. by $\frac{13}{16}$in., are £6 5s.; 4$\frac{1}{4}$in. to 6in. by $\frac{3}{16}$in., £6 15s.; and 1in. to 1$\frac{3}{4}$in. by $\frac{1}{8}$in., £7 5s. Large flats, of 3$\frac{1}{4}$in. to 4in. by 2$\frac{1}{2}$in. to 3in., are £6 10s.; 5$\frac{1}{4}$in. to 6in. by 1$\frac{1}{4}$in. to 1$\frac{1}{2}$in., £6 15s.; and 6$\frac{1}{4}$in. to 7in. by $\frac{3}{16}$in. to $\frac{5}{16}$in., £7 5s.

Messrs. G. Adams and Sons, of the Mars Ironworks, Wolverhampton, have just set going their new galvanised sheet works. These have been erected adjoining their black ironworks, and the laying out of the ground commenced with the new year. The new plant is particularly well arranged. The sheets are conveyed from the black iron mills to the annealing furnaces by a stout line of railway. These furnaces are worked upon a new principle, being heated by gas, supplied by patent producers, instead of by ordinary coal firing. This is a distinct advantage in the processes of manufacture. After passing through the pickling vats, the water tanks, and the roller baths, &c., the sheets enter a 12ft. corrugating machine, and lastly are passed through the straightening rolls. Steam power is supplied by a pair of 60 or 70 nominal horse-power horizontal engines, which are of the make of Messrs. Ormerod, Grierson, and Co., Manchester. The engines have a very complete appearance, and are mounted on an enamelled brick foundation. The new works start with a capacity of 150 tons of galvanised sheets per week, and, if needed, additional plant will be laid down at an early date. Orders are mainly anticipated from Australia, the Cape, and South America.

The pig iron market is waking up. Buyers with capital at their disposal believe that they cannot do wrong to lay in stocks at present low prices. They are, therefore, in several directions operating with freedom. Derbyshire, Lincolnshire, Northampton, and North Staffordshire irons are being purchased in preference generally to South Staffordshire brands. It is estimated that in one locality the arrivals of pigs in the last fortnight or so have aggregated quite 10,000 tons. For cash against delivery, sales are taking place much below the market figures. All-mine hot air pigs are 52s. 6d. to 57s. 6d.; cold blast, 75s. to 80s.; part mine, 35s. upwards; and cinder pigs, 2s. 6d. per ton below 30s. as a minimum. Northamptons are freely offered at 34s. at railway stations in this district, and Derbyshires are about 1s. to 2s. additional. Hematites are quoted 50s. to 52s. 6d., and second quality Welsh hematites are changing hands at 41s. 6d. to 42s. 3d. per ton delivered.

The South Staffordshire Mines Drainage Arbitrators have just considered applications for graduations of the new draft mines drainage award for the Tipton district. The rate on ironstone, coal, and slack is 9d. per ton, an increase of 3d. on previous years. The necessity for the increase arose out of the lessened amount of coal being raised simultaneously with a continued heavy expenditure by the Commissioners for pumping. The rate proposed on fire clay and limestone is 3d. per ton as before.

The ironworkers at the Trench and Stichley Ironworks, Shropshire, continue on strike against the masters' proposal to reduce wages, and so, too, do the workmen at the Cyclops Ironworks, Walsall. Happily the proprietors of the Clough Hall Ironworks, Kidsgrove, have found it unnecessary to carry into execution their threat to permanently close their establishment. The men have agreed to resume work at the old rate of wages, subject to seven days' notice to terminate contracts.

The bridge-building works are in fair operation, on account of contracts for Japan, &c. Contracts such as that which has this week been upon the market from the Indian Midland Railway Company, for a supply of steel and ironwork for four 100ft. clear span through bridges and six 75ft. span bridges, would be welcomed were they to be secured for this district. The current requirements of certain of the other Indian lines for pumps and boilers, iron colliery tubs, springs for carriages and wagons, &c., are also looked upon with satisfaction.

Pump engineers report an increase of orders, but at present the increase is not very pronounced, and American and continental competition has to be fought. There is a slight impetus in the vice and anvil trades.

The important works at Witton, near Birmingham, of Messrs. Kynoch and Co., ammunition manufacturers, are in a flourishing condition, and considerable extensions have lately been carried out, and new shopping erected. An area of twenty-five acres is now almost fully built upon, and the result of the extensions is to double the firm's capacity for producing sporting ammunition.

The manufacturing of solid drawn brass cartridge cases is carried on at the Witton Works in the following manner:—In the first instance, blanks varying from the size of a threepenny piece to 5$\frac{1}{2}$in. in diameter are stamped out. These blanks are next treated by a machine which, by means of a punch-like contrivance, converts them at one stroke into shallow pans. A repetition of this treatment in a similar machine brings the pan into the proportions, though not into the shape, of a thimble; and so the process goes on until the length required for the particular cartridge is obtained. After each stage in this process the metal is annealed, so that when the last stage is reached a perfectly homogeneous tube of brass, closed at one end, is obtained.

The strike in the fitting branch of the Wednesbury tube trade promises to end satisfactorily. Some of the men have accepted reductions ranging from 5 to 10 per cent., and the fitters at the works of Messrs. John Russell and Co. have resumed work at the prices fixed by the company. In the Wolverhampton tube trade, however, there in no indication of a termination of the strike.

The Council of the Birmingham Chamber of Commerce have determined to memorialise the Premier to resume the negotiations suspended in 1881 for an international monetary agreement, or, in the event of further inquiry being thought desirable, to appoint a Royal Commission to examine into the currency question. The same body have decided to place the following resolution upon the programme for the Congress of Chambers of Commerce of the Empire, to be held at the Colonial Exhibition on July 6th and 7th:—"That it is desirable to promote the federation of the Empire by the selection of eminent men from the various colonies and dependencies of Great Britain to represent their respective countries in the Imperial Parliament."

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—It is still the same monotonous report—no improvement either in prices or demand, with nothing encouraging in the prospects for the immediate future. If there is any change at all in the condition of the iron trade in this district, it is certainly not for the better; if anything, the excessively low cutting in prices to which some sellers have resorted to recently to secure orders, has tended to disorganise the market by stimulating amongst buyers notions as to prices on such a depreciated basis that very few makers would be at all willing even to entertain. The result has been that buyers have shown even less disposition to give out orders, whilst some makers, recognising the futility of attempting to follow buyers in their constantly receding ideas as to prices, have at length resolved to make a firm stand against any further concessions. There are, however, sellers who still show a susceptibility to pressure when buyers have actual orders to place, and although prices are nominally without alteration, there is a continued weak tone in the market both as regards pig and manufactured iron.

There was very little inquiry of any description stirring on the Manchester iron market on Tuesday, and the actual transactions recorded were extremely small. For Lancashire brands of pig iron makers still quote 37s. for forge and 37s. 6d. for foundry, less 2$\frac{1}{2}$, delivered equal to Manchester, but for open sales they are, on the basis of these figures, completely cut out by the low-priced district brands offering in this market, and transactions in local makes of pig iron are confined to occasional small lots sold to regular customers. In Derbyshire irons there seems to be a tendency towards weakness following upon the extremely low price at which one brand has for a few weeks past been offering here, and in Lincolnshire iron very low figures are also mentioned in the open market. The minimum actual selling price which is openly quoted in the market remains, however, at about 35s. 6d., less 2$\frac{1}{2}$, for No. 4 forge, delivered equal to Manchester, with one or two makers' prices at about 1s. per ton above this figure. Outside brands remain much about the same in price as last quoted, but both Scotch and North of England iron can be bought here at quite as low prices as ever, notwithstanding the somewhat firmer tone reported from Glasgow and Middlesbrough.

I do not find any reflex in this market of the improvement reported in some districts in the hematite trade. Buyers here are not putting forward any increased weight of business, and where orders are to be got the prices obtainable are no better. Buyers could still place orders at about 49s. 6d. for Lancashire and 50s. 6d. for Cumberland, No. 3 foundry qualities, less 2$\frac{1}{2}$ per cent., delivered into the Manchester district, although in some instances quotations are about 1s. per ton above these figures.

The manufactured iron trade remains in a stagnant condition throughout. Trade is no worse, and in some instances the orders given out are reported to be, if anything, rather heavier in weight, but the forges generally throughout this district are still very badly off for work, and the prices at which business is at all practicable are extremely low. The minimum quoted figures for delivery into the Manchester district remain at £4 17s. 6d. to £5 for bars, £5 7s. 6d. for hoops, and £6 10s. for sheets, but where there are orders for prompt specification to be got there are needy sellers who would be prepared with some concession to meet buyers if only to get work to keep their forges going.

Here and there a rather more hopeful tone seems to prevail in some branches of the engineering trade, but I do not find that there is any real improvement generally, and the returns which I quoted last week from the reports of the Trades Union Societies as to the lessened number of men out of employment have been received with some surprise amongst the representatives of the engineering branches of industry with whom I have come in contact. There is certainly no increased weight of actually new work giving out to warrant any appreciably increased demand for labour, and where better employment for the men has been found it is probably on small, odd jobs that are frequently given out with the close of the winter, but which do not indicate any increased activity in the general trade.

The Manchester Association of Engineers have once a year an excursion to some engineering centre of interest within accessible distance, and this year the well-known works of Messrs. Marshall, Sons, and Co., at Gainsborough, were thrown open to the members for inspection. The excursion was the most numerous that has yet been organised by the Society, about 120 members availing themselves of the opportunity, on Monday last, of visiting Messrs. Marshalls' works, and they were very generously entertained at dinner and tea by Messrs. J. and H. D. Marshall. It would be impossible in the brief space of these "Notes" to enter into any detailed description of the extensive works at Gainsborough, where, as agricultural engineers, the Messrs. Marshall have built up one of the largest and most completely fitted-up establishments of their kind in the county; and I can do no more than touch briefly upon one or two of the main features which chiefly attracted the attention of the members of the Association. The visitors were conducted by Messrs. James and Henry D. Marshall through the various departments of the works, and their extensive character was a surprise to all who had not previously an opportunity of inspecting them. The works themselves occupy an area of sixteen acres, of which nearly twelve acres are covered in by the various shops; and although nearly three hours was devoted to the visit, the time was barely sufficient for even the most cursory inspection. Perhaps the feature which, next to the extensive character of the establishment, most impressed the visitors was the orderly arrangement of the various operations carried on throughout the works, which have been designed throughout to economise labour to the fullest extent, the work, as far as possible, always moving forward in the various stages of progress, and the parts seldom traversing the same ground twice. The different branches of the manufacture of stationary and portable engines and boilers, agricultural machinery, corn mill and tea machinery were all seen in full operation, and there was but one opinion as to the general high-class character of the work turned out, the excellent finish of the boilers being especially noticeable. The modern character of the plant throughout the works, which have been fitted with the most approved tools and machinery for economising the cost of production, was also a feature which attracted general notice, and the visit all through was one of very great interest to the members of the Association. In bringing the day's proceedings to a close, Mr. Jas. Marshall proposed success to the Manchester Association of Engineers, coupling with it the name of their president, Mr. Ald. Bailey. They had, he said, felt a considerable amount of diffidence in inviting so important a representative association of engineers from Lancashire, which they considered the cradle of engineering. The trade depression which had been passing over England, and, indeed, one half the world, had affected agricultural engineering to a very material extent. There was, perhaps, some chance of this being modified in the immediate future, but he could see no very good times in store for them for a considerable period to come. In their works they had found one of the absolute necessities of the times was the cheapening of production, and with this end in view they had organised their labour and their plant to produce their goods on the most economical principles possible. In carrying out that work they had been indebted to many of the able engineers they saw around them that day, and they felt that their thanks were due to them for the great assistance they had received in fitting their works with labour saving appliances and special machine tools for various classes of work. Mr. Hy. D. Marshall, having cordially seconded the proposal, Mr. Ald. Bailey, in responding, expressed the pleasure which all the members had felt in visiting the splendid engineering works which had been so unreservedly thrown open to them that day. As bad trade had been mentioned by Mr. James Marshall, he might just remark that it was perhaps not quite so much what they called bad trade as the increased, the enormous, power of distribution which had been brought into existence by the engineer, that was responsible for the bad times they had been passing through. It was because everything was cheaper that times were bad, and because of the mechanical inventions contributed by the engineers of the world the merchants of the world were suffering. No doubt the people of the world were living under better conditions because of what the engineer had done. It was, however, hard for the capitalists, although it might be better for the world; but if there was any blame for bad trade he thought it must rest on the engineer, because of the work he had done. The wealth and the food of the world were, however, now spread so rapidly, that there would never again be a dearth over any particular region, and they had had no famines in recent times except where the locomotive and the resources of the engineer had not been brought in to assist in the food distribution. In going through Messrs. Marshalls' works he had been delighted to find the names of so many of their members on the tools and machinery they had seen in the different shops for the lessening of labour. He might say that Manchester was the birthplace of leisure, because it was by means of the tools made there they were enabled to work only fifty-four hours, and perhaps, as they got still more civilised, they might work only forty-eight per week, which was quite enough for any man, especially if he had to work with his head. A vote of thanks to Messrs. Marshall was, on the motion of Mr. M. S. Ashbury, C.E., supported by Mr. John Craven, Mr. Alderman Buckley, Mr. Councillor Asquith, and the Rev. Canon Hodgkinson, unanimously passed, and the proceedings then closed.

The coal trade remains dull throughout, with all descriptions of fuel for iron making and steam purposes plentiful in the market and very low in price. The tendency in the market is downwards, and it is not improbable that with the close of the month there may, in the Manchester district, be reduction both in prices and wages.

Barrow.—A better tone is reported in the hematite pig iron trade, but the actual trade done is not commensurate with the general improvement noticed in the demand and in the requirements of consumers. Makers in this district have booked themselves forward up to the end of August, and are slow to enter into any further sales at present prices. They are firm in maintaining 42s. per ton as the sale price of mixed parcels of Bessemer iron net at works, and 41s. for No. 3 forge and foundry iron. The Cumberland makers have been selling more cheaply, and needy sellers have pulled down prices somewhat, but the general disposition of trade is one of firmness, and it is probable that prices will not only be fully maintained, but the improved demand which is now experienced from America and elsewhere will help to raise prices to a still higher point. The stocks of iron held in Furness were reduced some time ago to *nil*, but at Carnforth and at Whitehaven very large stocks are held, while again at Millom they are very low. The district generally shows that rather less than two-thirds of the furnaces are in blast, but at Barrow ten out of fourteen furnaces are blowing, and it is probable others will be put in blast if the demand continues. In Cumberland during the past fortnight two furnaces which have been out of blast some time were relighted. The aggregate output of the district represents about 26,000 tons per week. There is a better outlook in the United States, and large sales of iron ore, pig iron, and blooms, may be looked forward to. Steel makers are busily employed in all departments except one. There is a good demand for steel rails, and makers are not only fully employed in this department, but they have orders in hand which will keep them employed for something like ten weeks. Prices are steady at £3 15s., and buyers are endeavouring to secure still lower rates. Tin-plate bars in full demand, but ship steel is very quiet. Shipbuilders are likely to secure one or two small orders, but the trade generally is quiet. Engineers, boiler-makers, and ironfounders are doing a very quiet business indeed, and there is only a temporary activity observable in the marine department. Iron ore quiet. Coal and coke steady. Shipping better employed.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Cleveland pig iron trade is still in an almost lifeless condition. There was a fair attendance at the market held at Middlesbrough on Tuesday last, but the amount of business actually transacted was quite unimportant. The leading firms decline to accept present rates, and indeed show little anxiety to sell at any price, as they believe they will shortly do better, seeing that shipments are improving. Merchants are not selling much, but they do not refuse 29s. 4½d. per ton for small lots of No. 3 g.m b. for prompt delivery. For forward delivery they quote 29s. 9d. per ton.

Warrants are offered at 29s. 9d. per ton, but there is no demand, and buyers are scarcely to be found even at 29s. 3d. per ton.

Messrs. Connal and Co.'s stocks of pig iron continue to increase rapidly, both at Middlesbrough and Glasgow. At Middlesbrough they hold 236,378 tons, which is an increase of 4973 tons for the week. At Glasgow their stock on Monday last was 762,229 tons, or an increase of 6509 tons. It will be noticed that the total quantity held by this firm is very nearly a million tons. A decided improvement has at last taken place in the shipments of pig iron from the Tees. The quantity sent away between the 1st and 24th of this month was 57,802 tons, as against 49,439 tons in the corresponding portion of April, and 51,460 tons in that of April, 1885.

The finished ironmakers who are still keeping their works in operation have great difficulty in securing sufficient orders, even at the reduced prices now current. Ship plates are now £4 10s., and bridge plates £4 12s. 6d. per ton at makers' works, less 2½ per cent. discount. Angles are £4 5s. per ton, and common bars £4 10s. per ton.

Steel makers are busy, and have sufficient orders on their books to last for some time. Prices are as follows, viz.:—Steel rails, £4 2s. 6d.; steel ship plates, £6 5s.; and steel angles, £6 2s. 6d. per ton. All free on trucks at makers' works.

The Durham coal trade seems as far off a revival as ever. Two pits belonging to the Earl of Durham are likely to be closed almost immediately. The number of colliers who will be thrown out of work thereby is estimated at from 100 to 130. They have received a fortnight's notice to terminate their engagements. Many of them have passed the whole of their lives hitherto in the neighbourhood of the collieries. The cause generally assigned for the cessation of operations is the depression of trade and a lack of demand for the produce of the collieries.

The annual meeting of the Northumberland Miners' Union was held on the 24th inst. at Newcastle; the principal item in the proceedings of public interest was the re-appointment of Mr. T. Burt, M.P., as secretary. It would appear that the honourable member is able to find time to carry on the business of a trades union, besides attending to his parliamentary duties. Not all of his constituents think that his services are worth what they have been paying him, for a motion was submitted to the meeting, proposing a considerable reduction in his salary. The majority, however, showed when they rejected the motion that they think a good secretary worth a good salary.

It would appear that the promised works for the defence of the mouth of the river Tyne have already been commenced. A number of men are engaged at the Trow Rocks, near South Shields. They are excavating a pit for the foundations necessary for placing in position a modern Woolwich gun of considerable weight and long range. Similar guns are intended to be placed in the Castle grounds at Tynemouth, and by one or other of these guns the entrance to the harbour will be so completely commanded that no hostile ship can approach without liability to be immediately sunk.

Mr. Waterhouse, accountant to the North of England Iron Trade Board of Arbitration, has just issued his report for the two months ending April 30th. The total make of all kinds of finished iron by those firms sending in returns to the Board was 49,563 tons, which is 5045 tons more than the output for the previous two months. This increase is entirely in the item of plates, the output of this speciality having been 31,321 tons, as compared with 26,241 tons in the previous return, the difference being 5080 tons. It is to be accounted for, not by any revival of demand, properly so-called, but by the fact that during the earlier period a strike was current at the shipyards, which caused a temporary interference with consumption. The report shows a slight increase in the make of bar iron, and a slight decrease in the make of rails and angle iron.

The average price of all kinds of finished iron has fallen from £4 14s. 9·64d. to £4 13s. 7d., or 1s. 2½d. per ton. This decline is shared nearly equally by each speciality. The fall in plates, however, which is the least, is 11d. per ton, and the fall in angles, which is the greatest, is 1s. 10d. per ton. This difference could hardly have been anticipated, inasmuch as the shipyard strikes must have equally affected both of these specialities. Wages will not necessarily be altered by this return, as there is not now any sliding scale in force in the manufactured iron trade of the North of England.

A strike commenced at the engine works of Messrs. Richardson and Co., of Hartlepool, on the 24th inst., the employers having given notice of a reduction of wages. The men were willing to make some concession, but not to agree exactly to the employers' terms. It is thought that an arrangement will be come to before long, but for the moment work is mostly suspended.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

BEFORE the sliding scale scheme, upon which so much depends for the peaceful and profitable working of the Yorkshire coalfield, can be settled, the Yorkshire Miners' Association find themselves called upon to take up a grievance which has been frequently referred to—the "confiscation of coal" at certain pits. The miners complain to the officials that they are continually sustaining loss by the practice which permits a whole "corf," weighing from 5 cwt. to 7 cwt., to be confiscated if it contains a certain percentage of "dirt." It is stated that at one colliery in twelve months upwards of 2200 corves of coal have thus been confiscated.

Messrs. Ward and Payne, edge tool and sheep shear manufacturers, are meeting with stubborn resistance in their demands for a reduction of wages to the extent of 15 per cent., or a revision of labour arrangements. On Wednesday night the firm were rattened, and though the rattener was seen at work burning the wheel-bands, he got clear off. His face was recognised, and the man, evidently aware of the fact, has made himself so scarce that the police have not been able to find him. The next night, Thursday, the premises of the firm were attacked by a crowd numbering some 2000 people, the idea being that German grinders were inside, and the crowd expressed their intention of waiting for the foreigners and "smashing" them. There were no Germans in the works, and the crowd contented itself with smashing the windows. The firm state that they will not be intimidated from the course they consider necessary to retain their markets. They require the adoption of the principle of division of labour, and they mean to have it—by their own workmen, for preference; if not by them, by German labour, which they will import for the purpose.

Wages reductions are not confined to iron and steel production. In the Rotherham district, six miles off, a large business is done in earthenware. The workmen employed at the potteries are asked to concede a fall of about 10 per cent., which has been rendered necessary, it is stated, by similar action having been taken in Staffordshire houses; 300 to 400 men are affected by the demand.

Messrs. James and Robinson, a Sheffield firm, have patented what they consider an important improvement in bicycles and tricycles. It consists of a spring boxed head, which removes, as far as is mechanically possible, all vibration and jumping. The spring is conical, resembles a railway buffer in miniature, and renders unnecessary saddle springs, handle springs, and rubber appliances. The rider swings on the spring, and the machine can be ridden on any road along which a carriage on springs can be driven, whilst it is further claimed that, by its use, additional power is obtained, with greater ease in ascent and safety in descent, and the wear of the machine reduced to one-half.

A new horseshoe, entitled the "Grip," has been brought out by a company, with premises in West-street, Sheffield, and is shown for the first time at the Sportsman's Exhibition, London. The objects of the shoe are to prevent all slipping, and the consequent injury to horses, to do away with all sharpening in winter and injury to hoofs, and by reducing the concussion on hard roads, save the horse's shoulders. The grip shoe was tried on several of the Sheffield roads during the severe winter. A horse drawing a heavily-weighted hansom was able to ascend and descend at a canter, without slipping, a very steep hill which was covered with ice, down which boys were skating.

The makers of heavy goods in railway material—except rails—are well employed, many of them working full time, and several overtime. In solid steel castings, marine forgings, armour plates, gun jackets, propeller blades, crank shafts, &c., there is no lack of work. One firm is working seven days a week. No rail orders have recently been placed in this district though the firms continue to quote against coast establishments and continental competitors. Home companies may continue to be supplied from inland districts, but the large export orders are certain to be taken by manufacturers who have their works close to the port of delivery, or enjoy the advantages of inland water navigation.

The colliers are in straits in several districts, the men having only about two days' work a week. Any prospect of advanced wages is entirely closed by the supply, even at this reduced rate of employment, being far in excess of the demand. Hundreds of loaded wagons can be seen at the railway sidings wherever accommodation can be found. The foreign demand for hard coal has also fallen off. There can be no real activity in the coal trade till the iron industry has improved; and, low as values rule now, it is not quite certain that "bottom" has been touched even yet.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

TWO things have contributed to increase somewhat this week the quotations of pig iron warrants on 'Change in Glasgow. One of these is the report that at least nine furnaces are to be put out of blast, and the other is the fact that the week's shipments have been larger than for a long time past. They amounted to 12,828 tons, as compared with 7993 in the preceding week, and 9130 in the corresponding week of 1885. There have, on the other hand, been larger additions than usual to the stock in Messrs. Connal and Co.'s stores, the week's addition being upwards of 6600 tons. Among the quantities of pigs despatched abroad are 2800 tons to Russia, 1264 to Canada, 1140 to Germany, and 740 tons to Italy.

Business was done in the warrant market on Friday at 38s. 4½d. cash. On Monday transactions occurred at 38s. 6d. to 38s. 4½d. The quotations on Tuesday forenoon were 38s. 5½d. to 38s. 7d. cash, and in the afternoon, 38s. 7d. Business was done on Wednesday at 38s. 7d. to 38s. 5d. cash. To-day—Thursday—transactions took place at 38s. 5½d. to 38s. 7½d., closing at 38s. 7d.

The values of makers' pigs are without quotable alteration, as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 42s. 6d.; No. 3, 40s. 6d.; Coltness, 46s. and 42s.; Langloan, 44s. and 41s. 6d.; Summerlee, 45s. 6d. and 41s. 6d.; Calder, 46s. 6d. and 41s.; Carnbroe, 42s. and 39s. 6d.; Clyde, 42s. 6d. and 39s. 6d.; Monkland, 39s. 3d. and 36s.; Quarter, 39s. and 35s. 6d.; Govan, at Broomielaw, 39s. 3d. and 36s.; Shotts, at Leith, 44s. 6d. and 43s. 6d.; Carron, at Grangemouth, 47s. 6d. and 44s. 6d.; Kinneil, at Bo'ness, 43s. and 42s.; Glengarnock, at Ardrossan, 42s. 6d. and 39s. 6d.; Eglinton, 39s. and 35s. 9d.; Dalmellington, 40s. 6d. and 37s. 6d.

Rumours are still current on 'Change in Glasgow of further prospective difficulties in the pig iron trade. The negotiations for restriction of output having failed, it was to be expected sooner or later that individual firms would be obliged to put out furnaces. Selling for the store has now been proceeding so long that merchants are becoming alarmed at the great and steady increase of stocks, and it was stated this week that as sales could not now be effected in the case of several descriptions of iron, the stoppage of a number of furnaces making it is only a question of time. This latter remark has no special reference to the case of the Coltness Iron Company, which is putting out four of the twelve furnaces in blast and intimating a reduction of wages. But the action of the company is all the same a sign of the times, and it is intimated that other five furnaces are being put out at other works. A number of firms are doing a good business in the manufacture and sale of hematite pig, and as the steel branch is rapidly superseding that of iron in Scotland, those firms who are preparing to take their share of the work have the best chance of not being left in a partially stranded position. One or two important houses can, of course, look upon the change with complacency, seeing that in addition to pig iron they have an important interest in coke, coal, and chemicals; but the rest have evidently hard times to encounter, unless there should come a marked and speedy revival of trade.

Some time ago general attention was called to the circumstance that American contractors had been successful in obtaining the order for a bridge in New South Wales. How they had been able to go below the other tenders was a mystery, but this is now explained by the fact that they have placed sub-contracts for the steel in the West of Scotland, and arranged that the bridge shall be built in Glasgow, and afterwards taken to pieces and shipped direct from the Clyde to New South Wales.

Within the last few weeks several of the large engineering firms in Glasgow and neighbourhood have been under the necessity of discharging a number of their workmen and placing the rest on short time.

There is now considerable activity in the Scotch coal trade, and if only some improvement could be obtained in prices there would not be much reason to complain. At present, however, this seems quite impossible. The past week's shipments embrace 25,739 tons at Glasgow, 4683 at Greenock, 3449 at Ayr, 2772 at Irvine, 5845 at Troon, 18,704 at Burntisland, and 13,752 at Grangemouth.

There is no movement of any consequence at present among the miners, who are obtaining fairly steady employment, and the more intelligent amongst the men must be convinced that at present there is no chance of obtaining higher wages.

The launches from Clyde shipyards in the past week embrace ten vessels, of an aggregate tonnage of 8640. Nine of these were steel steamers or yachts, representing 7490 tons, and the other two were iron sailing ships. It will be seen that the proportion of steel being used in shipbuilding is now becoming much larger than that of iron. Among the new contracts is one given by Messrs. Bell, Brothers, and M'Lelland, of Glasgow, to Messrs. D. W. Henderson and Co., also of Glasgow, to construct two first-class steel cargo steamers of 4000 tons dead-weight. Messrs. Barclay, Curle, and Co. have obtained from Messrs. Burns, of Glasgow, an order to build a strong cross-Channel steamer for their Clyde and Belfast trade; and a Govan firm is to construct two steamers of light draught for the tourist service on the Nile, and it is said they are to be fitted with boilers for raising steam with liquid fuel.

It may be of interest to state that the Association of Scotch Steelmakers has been dissolved, and each firm will be at liberty to accept orders at whatever terms they please.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

I AM told of no less than sixteen candidates for the position of H.M. Inspector of Mines, vacant by the death of Mr. Wales. Many good men are named. Mr. Wales was the first inspector appointed for the district, and was previously colliery manager at Dowlais. Singularly, by a sudden and fatal illness, the northern coal district of Glamorgan has also just lost its coroner, Mr. Thos. Williams, who had been associated with the inspector in most of the great colliery accidents.

The coal trade is certainly better this week. Last week's exports showed an improvement of 20,000 tons, and this has been sustained. Coalowners are beginning to entertain a belief in the improvement, although the week before last some falling off was noticeable, and, I am told, have decided to fight against the pressure brought to bear in keeping price down. Some coalowners, who at one time only worked the 4ft., and were generally 1s. ahead of other coalowners, still maintain a commendable firmness in quotations. Their present figure is 9s. 3d., and they get this. The present minimum generally is 7s. 6d., and from this to 9s. All sorts of prices prevail, figures being worked in harmony with necessity, or not, of prompt clearances.

It will take some time, even if the improving tone continues, for coalowners to recover from the long depression they have experienced. It is remarkable that so few bad results have come to the front—a proof that the majority of coalowners are substantial, and able to weather the storms which seem inseparable from the history of the coal trade. I regret to note a strike in the patent fuel trade. The various companies in the Cardiff district—Crown Preserved, Cambrian Star Company, and Anchor Company—have sought to enforce a slight reduction in loading rates at the docks, and this the men resist. Matters looked serious on Tuesday of an outbreak, and a resort to physical force; but at the time of my despatch there are more hopeful signs. Two large steamers were loaded by employing the men of the works and from Swansea; but an effort made to get new hands from Bristol was resisted, the men being intercepted and sent back. One good cargo of 725 tons left last week for Oran.

An industry associated closely with coal—that of pitwood—is beginning to suffer severely. A common figure in the moderately good times was 18s. to 20s., but present quotations vary only from 13s. to 13s. 6d.

There is a lull of expectancy in the steel trade, and men are anxious to see what next week will bring forth, all contracts terminating on the 31st of May at the whole of the works. It is feared that a reduction is inevitable, there being no change in the condition of things. Rails are being sold for £3 10s., but I am assured by a competent authority that they are not made for that figure. Probably two ends are made to meet by getting a little better figure for home supplies and small quantities. One of the principal features of the steel trade at present is the steel bar make for tinplate, and large quantities of these are being turned out. It is satisfactory to note that Cyfarthfa is tolerably well employed on these, and is turning out a bar that is certainly of the A1 class, and is much approved of.

There is not much said about steel sleepers for home railways at present. The fact is that railways are in a depressed state, returns being very small, and, until there is a revival, renewals and all possible expenditure will be kept low.

Taff Vale shares keep at 222. Swansea quotations for Dowlais bar are given at £5, angles £6; colliery rails were £5.

A new company has been formed by capitalists to reopen the tinplate works at Ystalyfera. This is accepted as a good sign; but what shall be said of the Gadlys Aberdare Works, a compact place, in a neighbourhood where labour is cheap, being put up for sale and withdrawn again—"no buyers"? At the sale, which took place this week, there was a clearance of the "properties" on the spot, and it is to be hoped, for the good of Aberdare, that the works will soon find a purchaser. There is an abundance of tinplate works at present, and large sales are effected, prices being low and tempting.

Cokes run from 13s. 3d. to 14s. Bessemers are quoted from 13s. 6d., and Siemens reach up to 14s. 3d., according to quality.

It is creditable to the Rhondda colliers that 1500 of them have joined in a vote of condolence to the widow of Mr. Wales, the late inspector.

Sir George Elliott is taking the most prominent place in Newport trade, and in the event of a dissolution will be brought forward to represent the district.

Coal was struck at Llansamlet this week, on the property of Mr. A. Thomas.

Some mineral properties in the Ogmore Valley are for sale.

LAUNCHES AND TRIAL TRIPS.

ON the 21st inst. Mr. Skelton launched at Millwall a small passenger steamer, for service on the river Quadalquiver. The vessel is 60ft. by 10ft. by 5ft., and is built of Siemens steel, decked all over with passenger cabins at each end and a wood awning above. The engines are compound surface condensing, 7½in. and 12in. by 9in.; return tube boiler of steel, made by Messrs. J. J. Seekings and Co., of Gloucester. The vessel was launched with steam up, and immediately ran a very successful trial trip, the speed attained being eleven miles per hour. It has been built to the order of Mr. I. White, of Seville, to which port she will steam out in the course of a few days.

A fine steamer for the Wilson Line, the El Dorado, to be engaged in the Norwegian passenger and mail service, was launched from Earl'es Shipbuilding and Engineering Company's Yard at Hull on Saturday last. The vessel has been built to replace the steamer El Dorado, sold at the beginning of the present war to the Greek Government, for an armed cruiser and despatch vessel. She is 250ft. long, 33ft. beam, and 23ft. 9in. depth of hold. She is on very fine lines, to enable her to attain a high rate of speed. Her large saloon will accommodate 80 passengers, and will be most handsomely fitted; and in every part of the ship the electric light will be used. The vessel has been built in several watertight compartments, and is exceptionally strong.

A fine steam trawler, the Margaret, was launched last week from the yard of Mr. Ald. Chorlton, engineer and shipbuilder, Hull. The Margaret is a sister-ship to the Catherine, Newcastle, and the Franco-Belge, lately built by the same firm. Her length of keel is 90ft.; beam, 19ft.; depth, 10ft. 6in. She has compound surface condensing engines, the cylinders of which are 14in. and 26in., and 18in. stroke. Her gross tonnage is 113, and her registered tonnage 61. She is classed 100A at Lloyd's, and both ship and engines have been built under their special survey.

THE FRENCH NAVY.—*Le Journal des Débats*, May 12th, has a leader on "La Réforme de la Marine," by M. Gabriel Charsnes. The leader is by Etienne Lamy. The course of the development of modern naval warfare is traced. Ironclad ships, with their artillery powers and ramming attack, are reviewed, as well as the effort to secure more widespread and distributed effect by torpedo boats. Eventually the conclusion is arrived at that the most promising power for a nation to develope is a great fleet of torpedo boats and light gunboats in order to prey upon the commerce of an enemy. This applies in full force only, of course, when that enemy is England. This has been dwelt upon before now in THE ENGINEER. Sir N. Barnaby's "Forecast," read at the U.S. Institution, first called attention powerfully to this question, and its importance can hardly be overrated. The vessels contemplated could be quickly built, and it is most necessary to be prepared to meet them. This provision might perhaps be made by supplying our merchant ships with great numbers of quick-firing and "anti-torpedo boat" machine-guns. A sufficient supply—but that would be an enormous one—would make the vessels contemplated liable to such quick destruction that it might fairly meet the case. Possibly also some special vessels of greater speed and power than the enemy's boats might also be needed. This would gradually destroy the special character of the scheme by ever calling for larger and larger vessels. England ought to be well prepared and ahead of other nations in this "mosquito" warfare; she ought now to be alive to it, and far beyond her present position in the matter. This brief review, it seems to us, might almost have been written in the interests of Messrs. White, Hotchkiss, Nordenfelt, and others. We may say then that it has taken this shape without the least intention that it should do so.

NEW COMPANIES.

THE following companies have just been registered:—

Southgate Engineering Company, Limited.

This company was registered on the 13th inst. with a capital of £10,000, in £5 shares, to carry on business as mechanical engineers, machine and engineering tool-makers, boiler-makers, iron and brass founders, &c. The subscribers are:—

	Shares.
A. Wright, The Crescent, Sydenham, accountant	1
D. G. Brown, 160, Kingsland-road, clerk	1
C. W. Bersley, Clifton-street, Clapham, reporter	1
W. S. Harrison, 23, Falkland-road, Kentish Town, clockmaker	1
W. Bowman, 11, King William-street, merchant	1
R. O. Thicke, 20, Budge-row, clerk	1
F. M. Downes, 26, Philpot-lane, merchant	1

Registered without special articles.

Self-Winding and Synchronising Clock Company, Limited.

This company proposes to acquire and work the letters patent No. 15,500, dated 25th November, 1885, for improvements in clocks, and apparatus for actuating or controlling the same by electricity; and also No. 7548, dated the 20th June, 1885, for "improvements in synchronisers for clocks," the inventions of Chester Henry Pond, of Brooklyn, New York. It was registered on the 19th inst. with a capital of £100,000, in £1 thares. The subscribers are:—

	Shares.
J. H. A. Macdonald, 38, James-street, Buckingham-gate	1
J. F. Saudeman, 31, Chesham-street, S.W., secretary to a company	1
W. Clarke, C.E., 45, Parliament-street	1
D. Boyd, Lynn, Cheshire, merchant	1
W. Leatham Bright, 118, Leadenhall-street, merchant	1
J. A. Lund, 49, Cornhill, watch manufacturer	1
C. G. Nottage, 35, Collingham-road, S.W., managing director of a company	1

The subscribers are to appoint the first directors. The number is not to be less than three nor more than seven; qualification, 200 shares; remuneration, £500 per annum, and a further sum equal to 10 per cent. of the amount divided amongst the members in excess of 10 per cent. per annum.

Cudlip and Sons, Limited.

Upon terms of an agreement of the 17th inst. this company proposes to purchase from Mr. Joseph Stevens Cudlip the business of paper manufacturer and merchant, carried on at the Brook Paper Mills, Little Eaton, Derby. It was registered on the 19th inst. with a capital of £25,000, in £5 shares. The consideration is £13,500 in fully-paid shares, £3000 in mortgage debentures, bearing 5 per cent. per annum interest, and £3512 15s. 8d. in cash. The subscribers are:—

	Shares
*J. S. Cudlip, Little Eaton, Derby, paper manufacturer	1
*E. G. Highton, Clapham Park	1
*J. S. Cudlip, jun., Little Eaton, paper manufacturer	1
J. B. Cudlip, Clapham Park	1
A. Weeder, Little Eaton, salesman	1
T. Coleman, Little Eaton, engineer	1
J. G. Naisley, Little Eaton, papermaker	1

The number of directors is not to be less than two nor more than five; qualification, one share; the first are the subscribers denoted by an asterisk; the company in general meeting will determine remuneration.

Gasking Patent Driving Belt and Leather Company, Limited.

Upon terms of an agreement of the 4th inst. this company proposes to purchase the various patents of Mr. Alfred John Gasking, of Lime Villa, Essex-road, Enfield, for the manufacture of bands or chains for the transmission of work. It was registered on the 14th inst. with a capital of £20,000, in £5 shares. The purchase consideration is £4000 in fully paid-shares, and £200 cash. The subscribers are:—

	Shares.
J. Aldewinckle, 18, Hosier-lane, E.C., manufacturing silversmith	1
D. Gilsenon, Sydney-road, Enfield, road surveyor	1
J. Chave Cox, 50, Claremont-road, Forest-gate, woollen merchant's agent	1
S. Chase, Brougham-street, Birmingham, flour salesman	1
F. H. Maberley, Hunter's lane, Birmingham, physician	1
G. Barker, 77, Colmore-road, Birmingham, consulting engineer	1
J. Aldewinckle, 56, Basinghall-street, manufacturer's agent	1

The number of directors is not to be less than three nor more than seven; qualification, ten shares. Most of the regulations of Table A are adopted. The vendor is appointed managing director at a salary of £41 13s. 4d. per month.

Great Grimsby Incorporated Chamber of Commerce and Shipping.

This association was registered on the 15th inst. as a company, limited by guarantee to £5 each member, for the promotion of the trade, commerce, shipping, and manufactures of Great Grimsby, and of the home, colonial, and foreign trade of the United Kingdom generally. The word "limited" is omitted by Board of Trade licence. The subscribers are:—

J. Reed, Grimsby.
H. Bennett, Grimsby, merchant.
E. Bannister, Grimsby, merchant.
J. Robinson, Grimsby, mercantile agent.
H. J. Ayre, Grimsby, shipping agent.
Walford Gomm, Grimsby, port master.
H. Smethurst, Grimsby, smack owner.
D. H. Bunz, Grimsby, merchant and consul.

The management will be vested in a council of twenty-seven elected members.

Macnab Patent Water Cartridge Company, Limited.

This company proposes to acquire and work the patent rights of Mr. James Macnab for "improvements in getting coal and other minerals, blasting or disintegrating rock, and in the apparatus to be employed therein, parts of which apparatus are also applicable to other purposes" (A.D. 1876), No. 3150. It was registered on the 14th inst. with a capital of £100,000, in £5 shares. The purchase is regulated by an unregistered agreement of the 29th ult. between the Patent Safety Hydraulic Cartridge Syndicate, Limited, of the one part, and Oscar James Perkins, representing this company, of the other part. The subscribers are:—

	Shares.
H. J. Budd, 121, Shooter's-hill-road, S.E., bookkeeper	1
O. J. Perkins, Endymion-road, Brixton, accountant	1
C. H. Norton, 31, Oxford-road, Finsbury Park, shorthand writer	1
A. J. Blizzard, 47, Vincent-road, Wood-green, shorthand writer	1
G. W. Ruffe, F.R.M.S., 131, Blackfriars-road, engraver	1
W. B. Caulfield, 73, Ferndale-road, Clapham, surveyor of shipping	1
E. Cook, 26, Wincott-road, Kennington, law student	1

The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first and act *ad interim*; qualification for subsequent directors 50 fully-paid shares. One-tenth of the divisible profits of the company (provided such profits do not exceed £50,000 in any one year, in which case the fixed sum of £5000) will, in each year, be divided amongst the members of the board.

London and Manchester Contract Corporation, Limited.

This company proposes to acquire and carry out contracts for public and other works, to act as patent agents, to buy, sell, and otherwise deal with real and personal property, and to transact business as bankers, merchants, financial, estate, and general agents, or as stock, share, bill, or produce brokers, or as promoters, founders, and originators of companies, &c. It was registered on the 15th inst. with a capital of £20,000, in £5 shares. The subscribers are:—

	Shares.
J. Norris Cooper, Ardwick, commission agent	1
J. Duckworth, West Gorton, commission agent	1
J. Coope, Prestwich, teacher of music	1
J. Hirst, Ardwick, bookkeeper	1
T. Buxton, 68, St. James-street, Manchester, pattern card maker	1
B. Kitchen, 30, Cross-street, Manchester, surveyor	1
W. Wilson Arkwright, Broughton-lane, Manchester, merchant	1

The number of directors is not to be less than three nor more than seven; qualification, 100 shares; the subscribers are to appoint the first; remuneration, £3 3s. each per meeting.

Nevada Nickel and Cobalt Company, Limited.

This company was registered on the 15th inst. with a capital of £250,000, in £1 shares, to acquire, work, and develope nickel and cobalt mines located in the Table Mountain Mining District, Churchill County, Nevada, U.S.A. The subscribers are:—

	Shares.
J. Buzley, 73, Wool Exchange, agent	1
M. J. Cunningham, Jeffrey's-square, E.C., agent	1
C. M. Thomas M.E., 7, Jeffrey's-square, E.C.	1
J. S. C. Callingham, 28, Burlington-road, W., clerk	1
R. R. Fastnedge, 2, East India-avenue, merchant	1
T. D. C. Parker, 81, Shaftesbury-road, N., accountant	1
J. J. Munden, 22, Church-road, De Beauvoir-square, merchant	1

The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first and act *ad interim*; the directors (other than the managing director) will be entitled to £1000 per annum, and a further sum equal to £5 per cent. upon the surplus divisible profits in each year, after payment of 10 per cent. per annum upon the share capital.

Queensland Export Company, Limited.

This company was registered on the 15th inst. with a capital of £100,000, in £10 shares, to acquire the business of freezing, preserving, and curing meat, carried on by Messrs. Gray, Dawes, and Co., at or near Bowen, in North Queensland, and the freehold and leasehold properties, machinery, plant, and effects used in connection therewith. The purchase is regulated by an unregistered agreement of the 6th inst. The subscribers are:—

	Shares.
*Sir Robert Burnett, Bart., Leys, Crathes, Aberdeen	1
*F. Neame, 12, Prince's-square, W., landowner in Queensland	1
A. G. Renshaw, 2, Suffolk-lane, solicitor	1
G. A. Brand, Bedford-hill House, Balham, merchant	1
R. Paul, 3, Tenterden-street, merchant	1
A. W. Macfarlane, Kempshott-road, Streatham, secretary to a company	1
J. Steuart, 2, Suffolk-lane, accountant	1

The number of directors is not to be less than three nor more than seven; qualification, £500 in shares or stock; the first are the subscribers denoted by an asterisk and Mr. George Sutherland Mackenzie. The remuneration of the board will be fixed at the first general meeting of the shareholders.

Castillon (Pyrenees) Mining Company, Limited.

Upon terms of an agreement of the 12th inst. this company proposes to acquire certain lead, silver-lead, and zinc mines situate in the arrondissement of St. Girons, department of Ariége, France. It was registered on the 14th inst. with a capital of £60,000, in £1 shares, 10,000 of which are 10 per cent. preference shares. The purchase consideration is £49,993 in fully-paid ordinary shares and £2600 in fully-paid preference shares. The subscribers are:—

	Shares.
A. Long Jeffree, 14, Great Winchester-street, contractor	1
W. Derry, St. Marazion, Cornwall, engineer	1
J. Bolton, 20, Great St. Helen's, chartered accountant	1
J. Cockburn, 11, Heathcote-street, Mecklenburg-square	1
W. M. Greenip, 1 and 2, George-street, solicitor	1
J. W. Vickers, 5, Nicholas-lane, advertising contractor	1
J. Walker, Hainhault House, Croydon	1

In lieu of special articles of association, Table A of the Companies' Act, 1862, will apply to the company.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Applications for Letters Patent.

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

18th May, 1886.

6632. GUNPOWDER, T. Bock.—(*C. Libbrecht, Belgium.*)
6633. VELOCIPEDES, &c., F. J. H. Axford, Salisbury.
6634. TUBES, SPOOLS, BOBBINS, &c., S. Wilson, Manchester.
6635. METALLIC FENCES, J. A. Cooper, France.
6636. STOPPERING BOTTLES, J. Greaves, Oldham.
6637. METALLIC FENCES, J. A. Cooper, France.
6638. PREPARING TEXTILE MATERIALS, A. Dronsfield, Manchester.
6639. CARDING ENGINES, G. and E. Ashworth, Manchester.
6640. WATER-CLOSETS, &c., J. Shanks, Glasgow.
6641. REARING BIRDS, W. H. Hillier, Nailsworth.
6642. AUTOMATIC MAGIC ADVERTISER, M. W. Utting, Anfield.
6643. TAPPING CASKS, &c., C. King, Leicester.
6644. SILENT REVERSIBLE TURNSTILE, J. Anderson, Newcastle-on-Tyne.
6645. ENDS for BRACES, &c., P. A. Martin, Birmingham.
6646. CLOSING ELECTRIC CIRCUITS, J. Enright, London.
6647. GAS, E. Mansfield, Manchester.
6648. CLEANING and POLISHING TINNED, &c., PLATES, J. Swain, Manchester.
6649. SCREW PROPELLERS, C. Hoehle, London.
6650. FACILITATING SWIMMING, H. Hart, Glasgow.
6651. RECORDING the NOTES, PEDALS, and STOPS PLAYED or ACTUATED in KEYED INSTRUMENTS, W. H. H. Muir, London.
6652. PLOUGH COULTERS, C. Downing, Sheffield.
6653. RIDDLES for MAKING BRICKS, &c., J. Higson, London.
6654. STEAM-JACKETTED BOILERS, W. Tijou, London.
6655. TYPE-WRITERS, D. E. Kempster and J. H. Currier, London.
6656. LADIES' SHOULDER BRACE and BUST SUPPORTER, A. E. Stout, London.
6657. BOX NAILING MACHINES, H. J. Allison.—(*W. S. Doig, United States.*)
6658. COOLING BEER, &c., J. Lüth, Glasgow.
6659. ADJUSTMENT of BALL or ROLLER BEARINGS, J. Jackson, London.
6660. STEERING GEAR for NAVIGABLE VESSELS, H. F. Moore, Liverpool.
6661. WORKING RAILWAY, &c., POINTS and SIGNALS, J. Hill, West Croydon.
6662. WIRE BRAIDING MACHINES, J. L. Wells, London.
6663. HYDRAULIC DOOR SPRINGS and CHECKS, J. J. Purnell, London.
6664. EXPLOSIVE COMPOUNDS, H. Schöneweg, London.
6665. AUTOMATIC LUBRICATING APPARATUS, R. Hoffmann, London.
6666. APPARATUS for EXHIBITING MAPS, PICTURES, &c., S. Connolly, London.
6667. FASTENING BLINDS, &c., to ROLLERS, G. R. McDonald, London.
6668. TREATING LEATHER SOLES, A. J. Boult.—(*G. E. Käsemodel, Germany.*)
6669. ELECTRIC VALVES, W. S. Johnson, London.
6670. OPERATING GAS ENGINES, L. H. Nash, London.
6671. TUBULAR COVERINGS of RUBBER, LEAD, &c., for WIRES, A. J. Boult.—(*W. D. Grimshaw, United States.*)
6672. BUCKLES, T. Mitchell, London.
6673. SMOKE-CONSUMING FURNACES, E. Fales, London.
6674. OPENING LATCHES or LOCKS of SCUTTLES, &c., A. J. Boult.—(*I. N. Rogers, United States.*)
6675. JET CONDENSERS, L. Schutte, London.
6676. SEPARATING or COLLECTING DUST, &c., from GRAIN, J. Higginbottom and O. Stuart, Liverpool.
6677. GRINDING MILLS, A. J. Boult.—(*B. Z. Taylor, United States.*)
6678. ELECTRIC BELL, C. Herz, London.
6679. METALLIC WIND MUSICAL INSTRUMENTS, J. C. Mewburn.—(*La Société A. Lecomte et Cie., France.*)
6680. SPRINGS for FOUR-WHEELED CARRIAGES, J. Parr, London.
6681. WETTING TRAM RAILS, J. Prosser, London.
6682. SPRAY LAMPS, J. Lyle, Glasgow.
6683. FURNACE for HEATING RIVETS, G. P. Thomson and H. Millar, Glasgow.
6684. SCREW HOOKS, &c., W. E. Cooke and F. Carter, London.
6685. PEN and PENCIL CASE or HOLDER, &c., G. H. Ellis, London.
6686. TREATMENT of ALCOHOL, &c., R. Jones, London.
6687. BRUSHES, J. J. Ashburner, London.
6688. WOOD PAVING, A. F. E. de St. Dalmas, London.
6689. MANUFACTURE of BRUSHES, J. Y. Johnson.—(*R. C. Fellows, United States.*)
6690. BORING for WATER, &c., by the AID of ELECTRICITY, R. Richards and H. R. Landon, London.
6691. MANUFACTURING ROLLED PLATE GLASS, J. French and J. Craig, London.
6692. PREVENTING COLLISIONS of RAILWAY TRAINS, C. Retzius-Ekwall, London.
6693. TOYS, H. H. Lake.—(*H. A. Plimpton, United States.*)
6694. ROUNDABOUTS, T. Blinkhorn and W. S. Key, London.
6695. WADING TROUSERS, T. G. Douglas, Edinburgh.
6696. PREPARATION of MEDICINAL EXTRACTS from the KAVA PLANT, P. Joske, London.
6697. DYNAMO-ELECTRIC MACHINES, N. Glouchoff, London.
6698. MANUFACTURE of CEMENTS and PLASTERS, L. White, London.
6699. HAND STRENGTH TESTER, A. F. Martel and R. Mitchell, London.
6700. UNIVERSAL CRAMP, H. Gregson, London.

19th May, 1886.

6701. MAKING OIL-SEED CAKES, J. Garrett and Son, Hull.
6702. OIL FEEDERS, R. Ramsay, Durham.
6703. APPARATUS for CLASSIFYING COUNTS from which CLOTH is MADE, H. B. Barlow.—(*E. Staub, Germany.*)
6704. DRILLING MACHINES, R. H. Read and S. Strickland, Tynemouth.
6705. ATMOSPHERIC GAS-BURNERS, T. Fletcher, Manchester.
6706. ROLLERS for FELTING MACHINES, C. S. Royle, Manchester.
6707. MACHINE for CLEANING the OUTSIDE of WINDOWS, A. Rochford, Dublin.
6708. COUPLING RAILWAY TRUCKS, &c., T. Melvin, Glasgow.
6709. JOINTS for METALLIC TUBES, J. Wotherspoon, Glasgow.
6710. DATE INDICATORS, J. J. Raggett, Birmingham.
6711. LOCOMOTIVE CARRIAGE, R. Brown, York.
6712. FISHING BAIT, H. Furnivall and J. Rigby, Birmingham.
6713. SHOP SEAT, R. A. Holmes, Leeds.
6714. MECHANISM of HAND LOOMS, L. E. Dubois, Halifax.
6715. SUPPORTING BICYCLES while at REST, D. W. Dickson, London.
6716. CHIMNEY STACKS, &c., W. H. Elphick and W. Davy, London.
6717. SHOES for HORSES, D. S. Jaffray, Glasgow.
6718. GAS ENGINES, R. Simon, London.
6719. POINTS for TRAMWAYS, J. Kincaid, London.
6720. GAS and COAL FIRE COOKING RANGE, J. Illston, London.
6721. ELECTRIC LAMPS, S. P. Thompson, London.
6722. ADMINISTRATION of DRY MEDICATED VAPOUR, W. H. Blenkinsop, London.
6723. DISINTEGRATING and PULVERISING CHARCOAL, J. T. Stammers, London.
6724. WATER MOTORS, A. D. Cock, London.
6725. CHAMBERS for DRYING CLOTHS, W. T. Buxton, London.
6726. CONSTRUCTION of ARROW, C. Wells, London.
6727. FIRE-ARMS and their CARTRIDGES, C. Wells, London.
6728. WHEEL, C. Wells, London.
6729. ORDNANCE, C. Wells, London.
6730. CUTTING and TRIMMING WOOLLY or FIBROUS FABRIC, H. Friedeberg, London.
6731. LOCK and LATCH CASES, H. Vaughan, Staffordshire.
6732. TREATMENT of SEWAGE SLUDGE, T. H. Cobley, London.
6733. WATER-TIGHT DOORS in SHIPS, G. A. Goodwin and W. F. How, London.
6734. LAWN-TENNIS APPARATUS, J. H. Greathead, London.
6735. RETAINING CARRIAGE WINDOWS at any HEIGHT, A. C. Hattatt, London.
6736. EXTRACTING OIL from FISH, &c., J. S. Edwards, London.
6737. VALVES and VALVE GEARING of ENGINES, J. H. Street, London.
6738. ELECTRIC LAMPS, J. W. Swan, London.
6739. PRODUCTION of ZINC BLOCKS from NATURE, E. Hill, London.
6740. SCALES for MEASURING, &c., J. H. Fraser, London.
6741. OIL LAMPS, M. Graetz, London.
6742. LAMP WICKS, M. Graetz, London.
6743. BOX FASTENERS, G. Adler, London.
6744. GAS-BURNERS, &c., H. J. Haddan.—(*J. Schülke, Germany.*)
6745. GRINDING and CRUSHING MILLS, H. J. Haddan.—(*The Foos Manufacturing Company, U.S.*)
6746. THERMOMETER HANDLE for WALKING-STICKS, &c., C. Moore, London.
6747. IRON ORES for the MANUFACTURE of STEEL, A. M. Clark.—(*La Société Anonyme des Produits Chimiques de St. Denis, France.*)
6748. HORSE ROUGH, H. W. Hooper, London.
6749. SELF-ACTING WINDOW-SASH FASTENER, G. Graham, London.
6750. GAS FURNACES, A. B. Cunningham, London.

20th May, 1886.

6751. MOUNTING ROLLERS in BRICK-MAKING, &c., MACHINES, R. Bradshaw, Swinton.
6752. GAS GLOBE and GAS JET HOLDERS, T. Eaton, Birmingham.
6753. ADVERTISING upon POSTAL ENVELOPES, &c., W. Pope, London.
6754. ANHYDROUS SULPHURIC ACID, R. H. Wilson, Durham.
6755. MOULDING DOUGH, J. Melvin, Glasgow.
6756. DOORS to enable them to be OPENED from the PRESSURE of a CROWD, G. Walker, Glasgow.
6757. SANDAL for BATHERS and SWIMMERS, W. Auld, Glasgow.
6758. PNEUMATIC MECHANISM of POWER HAMMERS, G. Glossop, Sheffield.
6759. SPADES and SHOVELS, R. Wallwork, Manchester.
6760. MOUNTINGS for LOOM TEMPLES, W. Tarbotton, Bradford.
6761. UTENSIL for CIGAR, &c., SMOKING, D. L. Brain, London.
6762. TREATING COTTON WASTE of LITHOGRAPHERS, &c., C. O'Neill, Manchester.
6763. SAD IRON and other HANDLES, J. Hughes, Birmingham.
6764. SCREW STOPPER and BOTTLE NECK, S. Bennett, S. E. Cooke, and W. Eccles, Stallybridge.
6765. TARGETS, W. O. Greener.—(*W. Huimann, U.S.*)
6766. VALVE GEAR for STEAM ENGINES, &c., R. Rickie, Glasgow.
6767. SECTIONAL WARPING MILLS, H. Stott, Halifax.
6768. SUSPENDING, &c., TROUSERS, &c., W. Hancock, London.
6769. COMBINED WATER SERVICE and WASTE-PREVENTING VALVES, W. Ross, Glasgow.
6770. BULL RING in COPPER, BRASS, or IRON, A. D. Melson and W. E. Addis, Birmingham.
6771. BOILERS for STEAM, &c., PURPOSES, C. E. Lee, London.
6772. MACHINE for CLIPPING GARDEN EDGES, W. E. Brooke, Rotherham.
6773. LOCKING DEVICES for SECURING RAILS to FISH-PLATES, &c., J. Hick.—(*T. R. Beaumont, U.S.*)
6774. TOY BUILDING BLOCKS, V. Loos, London.
6775. RING SPINNING and DOUBLING MACHINES, S. Brooks, London.
6776. PLANING MACHINES, R. Oldham, J. Richards, and W. Potts, London.
6777. SHIRTS, W. S. Finch, Liverpool.
6778. SUSPENDING SASHES, &c., J. Waller, London.
6779. SECURING the HANDLES to TABLE CUTLERY, &c., T. Crookes, Sheffield.
6780. WASHING PAPER and other PHOTOGRAPHS, J. T. Foster, London.
6781. RECEPTACLES for PENCILS, W. Jones and T. Sheffield, London.
6782. HIGH-PRESSURE and other BOILERS, B. Harlow, London.
6783. OPERATING SHUTTLE-BOXES, &c., W. Longbottom, Halifax.
6784. JOINING METALLIC PIPES, R. H. Taunton, London.
6785. PRINTING PRESS, J. Jordan, London.
6786. GALVANISING SHEET METAL, J. and T. L. Thomas and H. and E. W. Lewis, London.
6787. ADJUSTING the BACK of an ARM-CHAIR, R. H. Baveystock, London.
6788. PRESSING LOCK for PRINTERS' FRAMES, M. Protschko, London.
6789. PULLEY or SHEAVE BLOCKS, &c., G. Florence, Glasgow.
6790. MACHINES for DRILLING, &c., C. Burnett, London.
6791. HOLDING THINGS in POSITION, F. Bennett, London.
6792. OPEN-HEARTH FURNACES, F. Hilton, London.
6793. EASEL-STAND, R. Cross, Crewe.
6794. FACILITATING the TEACHING of ARITHMETIC, &c., R. Cross, Crewe.
6795. GAS LAMPS and PEDESTALS, J. H. Sheldrake, London.
6796. SPRING WASHERS for SCREW BOLTS and NUTS, J. W. Grover, London.
6797. STOP MOTIONS for LOOMS, F. Paas, London.
6798. BUTTON, S. S. Bromhead.—(*B. Tischer, France.*)
6799. CLEANING the GROOVES of TRAMWAY RAILS, A. W. Belfrage and A. Munro, Glasgow.
6800. PRODUCING PRINTING SURFACES, M. H. Dement, London.
6801. SLIDE VALVES, P. Hoppe, London.
6802. BITS for HORSES, J. Hawkins, London.
6803. SEPARATING METALLIC TIN from TINNED PLATES, &c., E. Edwards.—(*M. Ramos-Garcia, France.*)
6804. PREVENTING the RADIATION and TRANSMISSION of HEAT, R. W. Hitchins, London.
6805. ELECTRIC ARC LAMPS, R. H. Courtenay, London.
6806. INCANDESCING MEDIUM of ELECTRIC LAMPS, &c., T. Mace.—(*The Vitrite and Luminoid Company, U.S.*)
6807. ANCHORS, J. Hartness, London.
6808. AUTOMATIC GAS REGULATORS, J. Mackenzie, London.
6809. PACKING and PROTECTING GOODS, &c., C. H. Russell, London.
6810. EXTRACTING GOLD, &c., from ORES, J. Noad, London.
6811. COMBUSTION of GAS for ILLUMINATING PURPOSES, J. Mactear, London.
6812. CHOPPING or REDUCING MACHINES, E. Graddon, Catford.
6813. FILTRATION, J. G. Lorrain, London.
6814. ATTACHING and DETACHING ANIMALS to and from VEHICLES, A. J. Blew, London.

21st May, 1886.

6815. WHITING, W. Corbould, London.
6816. FORMING GROOVES around the END of BOXES, &c., D. Rylands and J. Wegg, Barnsley.
6817. METAL DOORS and FRAMES for BUILDINGS, J. Partington, Bradford.

6818. BLOWING ENGINES, J. F. A. Pflaum, Potternewton.
6819. SUBSTANCES for ANTISEPTIC PURPOSES, W. Thomson, Manchester.
6820. LAWN TENNIS and other RACQUETS, I. T. Townsend, Attleborough.
6821. VENTILATION of BEE-HIVES, J. Rudge, Dursley.
6822. POLISHING SEWING NEEDLES, &c., N. Kuck, Redditch.
6823. TRAPS for CATCHING ANIMALS, T. R. Cattell and A. H. Summers, Birmingham.
6824. SULPHATE of ALUMINA, D. G. McLellan.—(*P. K. Oushkoff and J. Y. McLellan, Russia.*)
6825. KNOBS, C. Priestland, Birmingham.
6826. BOX NAILING MACHINES, T. N. Robinson, Manchester.
6827. HORIZONTAL SAW FRAMES, T. N. Robinson, Manchester.
6828. CLEARING the DRAWING ROLLERS of SPINNING MACHINES, B. A. Dobson, J. Cheetham, and R. H. Robinson, Manchester.
6829. WOOD and IRON HOUSES for CARRIAGES, &c., J. Elwell, Birmingham.
6830. OPENING GATES when RIDING, &c., D. Jones, Lymington.
6831. STENCH TRAPS, P. J. Davies, London.
6832. PERAMBULATORS, &c., M. Moses, London.
6833. BRUSHES, W. J. Payne, London.
6834. STRIPPING FILES, &c., W. Turner, Sheffield.
6835. MATCH and FUSEE BOXES, G. Evans, London.
6836. PROTECTION of FENCES, &c., G. Nunn, London.
6837. FASTENING BUTTONS, R. Jones, London.
6838. BRAKES for TRAMCARS, A. Leitch and T. Liddle, London.
6839. ELECTRICAL APPARATUS for INDICATING the SPEED of SHAFTS, &c., W. T. Goolden, A. P. Trotter, and P. Cardew, London.
6840. DRAWING-OFF GRAIN from STORE-BINS, W. Hollinshead-Sprague, London.
6841. DETACHABLY ATTACHING COLLARS, &c., to SHIRTS, W. Childs, London.
6842. DISTILLING VOLATILE LIQUIDS and GASES, T. T. Matthieson and J. Hawliczek, Liverpool.
6843. CASTORS, W. Bradley, London.
6844. MOTOR ENGINE, J. C. Sellars, Liverpool.
6845. PRIMARY and SECONDARY BATTERIES, P. Bailly, London.
6846. VERMIN TRAP, W. G. Everitt, London.
6847. COMBINATION VELOCIPEDES, P. Rees, London.
6848. VIEWING PICTURES, &c., J. B. Ferry, London.
6849. RECEPTACLE for WASTE PAPER, J. Spear, London.
6850. PREVENTING CONCUSSION in WATER PIPES, G. F. Redfern.—(*G. Richert, Sweden.*)
6851. TRAWLING NETS, C. Wells, London.
6852. GAS HEATING APPARATUS for BATHS, C. Wells, London.
6853. CHINOLINE DERIVATIVES, J. Y. Johnson.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
6854. FORK GUARD SPRINGS, H. M. Smith, London.
6855. BALL BEARINGS, W. P. Thompson.—(*W. H. Wright, United States.*)
6856. WRITING SLATE FRAMES, O. J. Owen, Liverpool.
6857. CONVERTING TANK WATERS into FERTILISERS, J. V. Ruymbeke, London.
6858. HEATING APARTMENTS, A. J. Boult.—(*A. Montenegro, Spain.*)
6859. GENERATING INFLAMMABLE VAPOURS, A. M. Clark.—(*C. A. Paquelin, France.*)
6860. INDIA-RUBBER HOSE, C. H. Gray, London.
6861. WEAVING ELASTIC FABRICS, C. H. Gray, London.
6862. CHAINS, &c., A. H. Imbert and J. P. A. Léger, London.
6863. ELECTRO-MAGNETIC STRINGED MUSICAL INSTRUMENTS, R. K. Boyle, London.
6864. MOUNTING PICTURES, H. H. Lake.—(*R. H. L. and E. Talcott, United States.*)
6865. APPLIANCES CONNECTED with TRAPS for SINKS, J. Asbury, London.
6866. METALLIC TELEGRAPH POLES, J. C. Johnson, London.
6867. CARRIAGE LAMPS, A. Winkley, London.
6868. FACILITATING the SKETCHING of LANDSCAPES, L. West, London.
6869. TRANSFORMING HEAT into ELECTRICITY, C. Clamond, London.

May 22nd.

6870. COUPLING APPARATUS, G. A. Nussbaum, London, and E. G. Matthewson, Willesden.
6871. FILING and BINDING LETTERS, T. Scragg, Stoke-on-Trent.
6872. MAKING METAL PLANING MACHINES, F. B. Welch, Manchester.
6873. EARTHENWARE PIPES, F. Holt, Manchester.
6874. FLOWER BASKET, R. Burtles, Manchester.
6875. MACHINES for MOULDING WOOD, J. Sagar, Halifax.
6876. ADJUSTABLE SLIDING EASEL, J. Gough, Birmingham.
6877. FIXING PLATES on PLANING MACHINES, C. Carter, Manchester.
6878. REVERSING MOTION and AUTOMATIC BRAKE, E. Wood, Leeds.
6879. BLIND ROLLER BRACKETS, C. Homer and S. Bott, Birmingham.
6880. NOSE-BAGS for HORSES, &c., G. P. Lemprière and T. Askey, Birmingham.
6881. SAFETY STEERAGE of PERAMBULATORS, J. Aylward, Coventry.
6882. HOT AIR APPARATUS, &c., A. P. Holland, Blackburn.
6883. VESSELS for BOILING LIQUIDS, A. P. Holland, Blackburn.
6884. CARD CLOTHINGS of CARDING MACHINES, J. Holden, Paris.
6885. AERATED LIQUIDS, J. P. Jackson, Liverpool.
6886. COMPRESSING MACHINERY, J. Whetnall and G. H. Richmond, Manchester.
6887. MIXING MACHINES, G. E. Sherwin, Aston.
6888. SLEEPERS, T. Child, Leeds.
6889. PISTONS, E. Jones, Ruabon.
6890. PIGEON TRAPS, W. O. Greener.—(*W. Binman, United States.*)
6891. PACKING RINGS, C. Carter, Manchester.
6892. STOPPER FASTENER for BOTTLES, F. W. Pittuck, Hebburn-on-Tyne, and J. C. Snowdon, Newcastle-on-Tyne.
6893. APPARATUS for PURIFYING FLUIDS, G. Sagasser, London.
6894. METAL BATTEN PIN, C. F. Whale, London.
6895. MILLING MACHINERY, J., G., J., T., and J. W. Garside, Halifax.
6896. AFFIXING STAMPS to POSTAL PACKETS, O. Brown, London.
6897. SAFETY ROAD GATES, A. J. Boult.—(*E. S. Piper, Canada.*)
6898. LIFE-BOATS, R. Chambers, Glasgow.
6899. TONIC BITTERS, S. Waters, London.
6900. COMBINED LATHE, CIRCULAR SAW, and ANGLE CUTTER, W. Sanday, London.
6901. CRAMPS for PUTTING TOGETHER PICTURE FRAMES, W. Sanday, London.
6902. MUSICAL BELL MECHANISM, H. J. Haddan.—(*J. Werner, Germany.*)
6903. STEAM ENGINES, P. F. Hübner, London.
6904. CALORIC ENGINES, W. G. Hudson, Manchester.
6905. LOCK MECHANISM for SAFES, E. P. Alexander.—(*H. Gross, United States.*)
6906. BURGLAR-PROOF SAFES, E. P. Alexander.—(*H. Gross, United States.*)
6907. SAFES, &c., E. P. Alexander.—(*H. Gross, U.S.*)
6908. MANUFACTURE of BITUMINOUS FELTS, W. B. Ritchie, London.
6909. PERCUSSION CAPS, &c., C. D. Abel.—(*W. Lorenz, Germany.*)
6910. ANCHORS, E. Reynolds, London.
6911. VELOCIPEDES, &c., W. G. May and R. Taylor, London.
6912. MANUFACTURE of WOOD MOULDINGS, G. W. Butt, London.
6913. CORKSCREW, E. Blacking, London.
6914. SHEDDING MOTIONS for LOOMS, &c., E. Brook, London.
6915. SHUTTLE-PEG for USE in BOBBINS, R. Martin, London.
6916. CONSTRUCTION of VESSELS, &c., T. R. Oswald, London.
6917. FLUORIDE of ALUMINIUM, W. L. Wise.—(*Oesterreichische Anilin-fabrik Strakosch and Co., and C. O. Weber, Austria.*)
6918. AUTOMATIC SHAFT SUPPORT, W. H. Vaughan and T. Foster, London.
6919. HEATING STOVES and FURNACES, E. Edwards.—(*K. Wehse, Germany.*)
6920. ACTUATING the BOLTS of DOORS &c., E. Edwards.—(*L. Radi, France.*)
6921. BAKING-TIN or PAN, H. W. Hart, London.
6922. STAMPS for FISCAL &c. PURPOSES, W. C. Homersham, London.
6923. BALANCED SLIDE-VALVES, E. P. Plenty, London.
6924. WORKING ELECTRICAL BATTERIES, J. T. Armstrong, London.
6925. ELECTRICAL INTERCOMMUNICATION between CARRIAGES of RAILWAY TRAINS, A. M. Clark.—(*M. M. Bair, France.*)
6926. SAWING MACHINES, A. M. Clark.—(*J. H. Whitaker, United States.*)
6927. BOBBIN WINDERS, H. Lefeber, London.
6928. LOTION, A. Barber, London.
6929. SADDLES of BICYCLES, &c., J. Clay, London.
6930. FIRE-PLACES, H. Heim, London.
6931. ROTATING SHAFT, J. Thorne.—(*T. Horn, Germany.*)

May 24th.

6932. WOVEN FIGURED FABRICS, T. Taylor and J. Warburton, Manchester.
6933. OUTRIGGERS for BOATS, H. Dickinson, Burton-on-Trent.
6934. SAW-FILING MACHINES, S. C. Rogers, Hamilton, Canada.
6935. TYPE WRITERS, A. P. Eggis, Manchester.
6936. PHOTOGRAPHIC CAMERA STAND, J. Brown, Belfast.
6937. CUTTING MACHINES for CLOTH FINISHING, J. Sunderland, Huddersfield.
6938. RABBIT and VERMIN TRAPS, G. D. Wood, Wednesfield.
6939. LIFTS or HOISTS, S. and T. Newton, Manchester.
6940. SPINNING, &c., MACHINERY, J. W. Midgley, Yorkshire.
6941. CLIP HOOKS, W. O. Walley, Manchester.
6942. ORNAMENTING TUBES for STRUCTURAL PURPOSES, F. R. Baker, Birmingham.
6943. CONICAL-SHAPED TUBE VENTILATOR, E. G. Wright, Portsmouth.
6944. CARDING of FIBRES, G. Goldthorp, Halifax.
6945. FLUSHING TANKS, J. M. Lamb, London.
6946. CHEMICALLY TREATING RAGS, &c., J. Priestley, Wakefield.
6947. FAUCET PORT and STOPPER COMBINED, W. J. Woodley and C. H. F. Reed, Liverpool.
6948. CARBURETTING AIR, Y. A. Gaston, Liverpool.
6949. ROLLER MARKING or PRINTING APPARATUS, T. B. Sloper, London.
6950. ROTARY DUST COLLECTOR, G. Kiefer, London.
6951. BEEHIVES, A. W. Rollins, Birmingham.
6952. TIPPING WAGONS, G. R. Turner, London.
6953. VULCANISED RUBBER, &c., FABRICS, E. M. Freeley, London.
6954. CASTORS for FURNITURE, &c., E. W. Hughes and J. Altschul, London.
6955. OARS or SWEEPS, G. W. Green, London.
6956. PALATE PLATES for ARTIFICIAL TEETH, J. Wallace, Glasgow.
6957. GALVANIC BATTERIES, M. Kotyra, London.
6958. AGITATING LIQUIDS, J. Gamgee, London.
6959. SPLIT RING, J. Webster, London.
6960. SECTIONAL STEAM GENERATORS, C. A. Knight, Glasgow.
6961. CAPS and CLAMPS for HAND HOLES, &c., in STEAM GENERATORS, C. A. Knight, Glasgow.
6962. MUSICAL BOXES, E. Fornachon, London.
6963. STAIR RODS, J. W. Spurway, London.
6964. SHEET METAL BUCKETS, W. J. Howcroft and A. C. Moore, London.
6965. PRODUCING COMPOUNDS of LAEVULIC ACID, C. D. Abel.—(*The Farbwerke vormals Meister, Lucius and Brüning, Germany.*)
6966. DEODORANT and DISINFECTANT, H. M. Caldwell, London.
6967. BOOTS and SHOES, J. McGuigan, London.
6968. CONDUITS for ELECTRIC CABLES, H. H. Lake.—(*J. F. Munsie and H. N. May, United States.*)
6969. ELECTRIC BATTERIES, G. V. Lagarde, London.
6970. HEATING STOVES or FIRE-GRATES, J. B. Petter, London.
6971. CLINOMETERS, G. P. Evelyn, London.
6972. CRINOLINE, &c. STEEL, W. E. Whale, London.

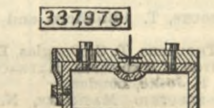
SELECTED AMERICAN PATENTS.

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

337,979. METHOD OF TEMPERING METAL, *Samuel E. Mower, New Haven.—Filed August 31st*, 1885.

Claim.—The herein described method or process of hardening or tempering steely metal, which consists in passing heated metal through water or other fluid between a packing of asbestos or other non-combus-

337,979.

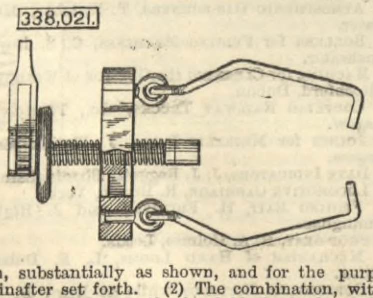


tible material, whereby the said fluid is prevented from reaching the metal above the packing, thereby tempering only a part of the said metal, substantially as described.

338,021. DRILLING MACHINE, *Franklin Bennett, Marshallville, Ohio.—Filed November 12th*, 1884.

Claim.—(1) The combination, with a head block provided with hinged pendant hooks and having parallel ways and a nut fitting in said ways and arranged to slide therein, of a hollow feeding screw fitting said nut, provided with a hand wheel and inclosing a drill shaft provided with driving mecha-

338,021.

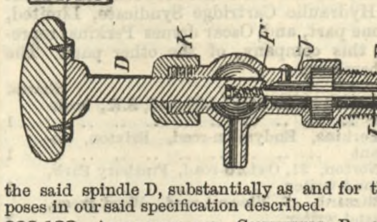


nism, substantially as shown, and for the purpose hereinafter set forth. (2) The combination, with a hook connected with the head block of a hand drill press, of a plate I having two flanges *i i*, with intermediate formation arranged to fit on said hook, substantially as shown, and for the purpose specified.

338,215. GAUGE COCK, *James B. Atwood, Boston, and Samuel H. Howes, Chelsea, Mass.—Filed August 20th*, 1885.

Claim.—(1) The gauge cock body C, constructed with the perforations J and K and perforations for pin I. (2) The spindle D, constructed with the bore and internal screw thread at F, said thread being twice as coarse as the external thread near the centre of said spindle, used in connection with and working upon the external screw thread at end of spindle E, for tb purpose of transmitting from the said spindle , said spindle E a positive, equal, and simultaneous motion in a direction opposite to that traversed by

338,215.

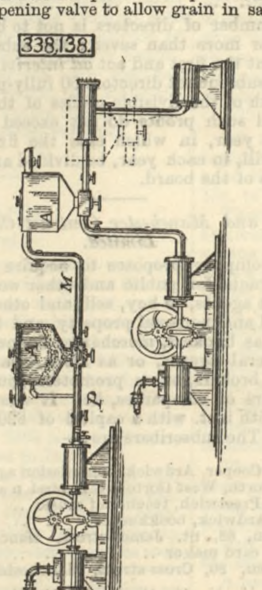


the said spindle D, substantially as and for the purposes in our said specification described.

338,138. APPARATUS FOR CONVEYING PARCELS OR GRAIN BY ATMOSPHERIC PRESSURE, *Chas. E. Buell, Springfield, Mass.—Filed June 1st*, 1885.

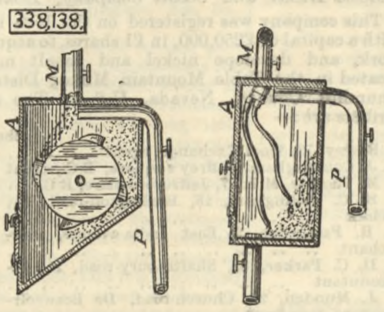
Claim.—(1) In a pneumatic carrier system, the air-tight receptacle A, motor gas inlet, and the main M, opening from said receptacle and provided with an outwardly-opening valve to allow grain in said recep-

338,138.



tacle to pour into said main, and a receiver for the transmitted grain provided with an elastic or yielding medium to receive the grain without injurious impact, substantially as described. (2) A pneumatic tube in sections, each provided with a valve or gate hung pendulous within said section, and an air escape vent

338,138.

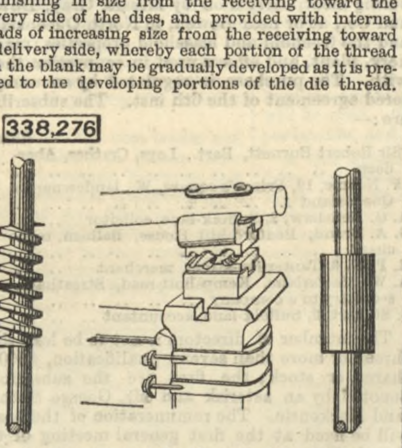


between said gate and the contiguous section, substantially as described. (3) In a pneumatic carrier system, a double main M M^1 for transmitting material in opposite directions, combined with a single supply pipe P and valvular connections therewith, substantially as described.

338,276. DIE FOR SWAGING SCREWS, *Burr A. Kennedy, Lake View, Ill.—Filed January 5th*, 1885.

Claim.—(1) The herein-described method of forming screw threads, consisting in passing the blank slowly in an endwise direction between a pair of converging dies, which are threaded internally and reduced in diameter from the receiving toward the delivery side, whereby the threads are gradually developed on the blank. (2) A pair of screw converging dies with complementary forms or cavities therein, said cavities diminishing in size from the receiving toward the delivery side of the dies, and provided with internal threads of increasing size from the receiving toward the delivery side, whereby each portion of the thread upon the blank may be gradually developed as it is presented to the developing portions of the die thread.

338,276

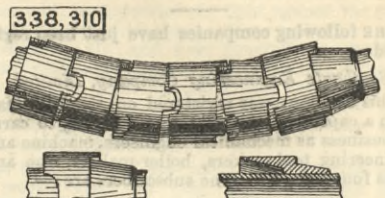


(3) As an improvement in the art of forging screw threads, the method consisting in first passing the blank between tapering internally-threaded forming surfaces, and subsequently between forming surfaces of smaller internal diameter having threads of constant form and size therein. (4) Complementary screw-forging dies provided with tapering internally-threaded forms or cavities to produce the crude thread, and the finishing form of smaller internal diameter threaded in exact conformity to the required screw. (5) The complementary dies for finishing screw threads, having the internal forms or unthreaded recesses F F' of semicircular section and uniform diameter, and the internal threads of uniform size throughout their entire length, whereby said dies are adapted to finish the threads for use and at the same time to maintain the screw in a perfectly straight condition.

338,310. ARMOUR FOR RUBBER HOSE, *James M. Smith, Sycamore, Ill.—Filed June 15th*, 1885.

Claim.—(1) The combination of a rubber or other flexible hose with a series of overlapping metallic rings, substantially as described and shown, about the same, as a protecting cover therefor. (2) A hose cover consisting of a series of rings dovetailing with each other, substantially as described and shown, whereby twisting of the hose is prevented. (3) A hose cover consisting of rings B, inwardly bevelled from one end for substantially their whole length, and provided at the other end with the conical projection C, of a length corresponding to the bevel, substantially as described and shown. (4) The section of hose cover B, conical

338,310

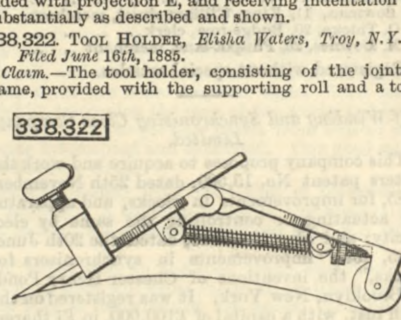


at one end, bevelled inwardly at the other and provided with projection E, and receiving indentation F, substantially as described and shown.

338,322. TOOL HOLDER, *Elisha Waters, Troy, N.Y.—Filed June 16th*, 1885.

Claim.—The tool holder, consisting of the jointed frame, provided with the supporting roll and a tool

338,322

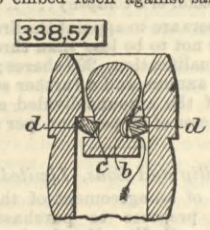


clamping device at opposite ends, and with means, substantially as described, for adjusting the angle of the jointed parts with respect to each other.

338,571. VALVE STOPPER FOR BOTTLES, *Arthur B. Vanes, Uitenhage, Cape of Good Hope.—Filed July 1st*, 1885.

Claim.—(1) A stopper in which the valve consists of a rigid flange or disc on the bottom of the body of the stopper, combined with an elastic ring or washer supported on such flange, said stopper having on the upper side of said flange a circular rib or projection b^2, adapted to embed itself against said rubber and

338,571

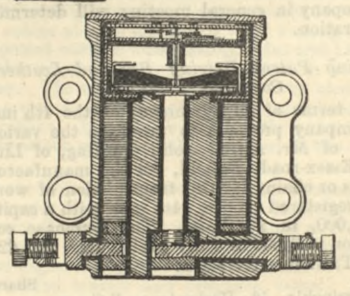


having a groove or grooves *h*, as and for the purpose set forth. (2) In combination with a rigid stopper body, having the bottom flange *b*, and groove *c*, the rubber valve ring *d*, fitted in such groove and having in it one or more small perforations e^2, all as and for the purposes set forth.

338,588. ELECTRIC METER, *Sebastian Z. de Ferranti, West Kensington, Middlesex, England.—Filed October 6th*, 1884.

Claim.—(1) The combination in an electric meter of *a* a bath of mercury, or other conducting liquid, through or across which the current to be measured is made to pass radially; *b* a magnet or a coil of an insulated conductor through which the current is also passed, in the magnetic field of which the bath is located; and *c* mechanism for recording the rotation set up within the mercury bath by the passage of the current. (2) The combination in an electric meter of *a* a bath of mercury, or other conducting liquid, through or across which the current to be measured is made to

338,588

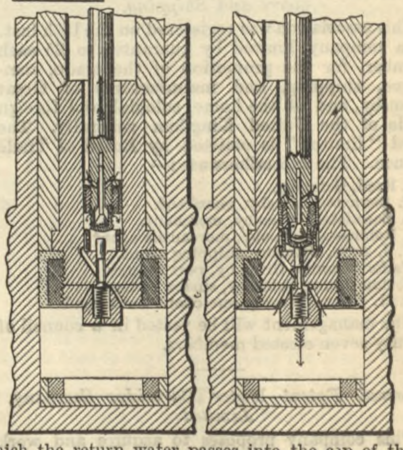


pass radially; *b* a magnet or a coil of an insulated conductor through which the current is also passed, in the magnetic field of which the bath is located; *c* a solid totally submerged in the mercury contained in the bath, and *d* a spindle passing upward from the said solid to the recording mechanism. (3) In an electric meter, the combination of a body of mercury, or other conducting liquid, through which the current to be measured is passed, a magnet or electric coil, in the field of which said body of mercury or other conducting liquid is disposed, so that when a current passes the mercury is caused to move or travel in its receptacle, and recording mechanism for making a record of such movement or action of the mercury or other conducting liquid.

338,598. HYDRAULIC JACK, *Charles Huebner, Brooklyn, N.Y.—Filed January 20th*, 1886.

Brief.—An apertured bushing in the lower part of the cylinder, forming an annular chamber through

338,598



which the return water passes into the cap of the piston, over the valve therein, and thence to the cylinder bore above the piston, thus avoiding the closing of the valve by the pressure of the water. In operation the cap only of the piston enters the bushing, so that the apertures in the latter cannot cut the packing.